THE

ELECTRICAL REVIEW.

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THE

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NIAGARA.

PROF. ROWLAND, the well-known American physicist, has been awarded the balance of $9,000 paid for a report delivered by him to the Cataract Construction Company. The case, which possesses unusual interest, was decided in Court by a jury. The evidence throws a vivid light upon the origin of the Niagara plans, and reveals some interesting features in the consulting engineering profession as carried on by professors. It appears that Prof. Rowland was consulted by the Cataract Company, and sent in a report upon which he alleged he had spent seven hours a day during six months, and for this work he sent in a bill amounting to $10,000. The company paid him $3,500 dollars, which they considered enough for the work done; but Prof. Rowland then intimated that his first bill was a mistake, as he had charged too little, and thereupon sent in a charge for $30,000. The jury awarded $5,500 dollars, the unpaid balance of $9,000, thus declaring the professor was entitled to be paid for his work. This decision does not, however, settle the questions as to who originated the Niagara plans as now adopted by the company. Prof. Forbes, who appeared for the defence, testified that the whole scheme had been drawn up and decided upon before he saw Prof. Rowland's plans. Prof. Rowland claims that the scheme submitted by him, and his report, are those accepted; while the Westinghouse Company claim that the designs and details originated with their own engineers. We have already in our previous articles expressed a hope that the Construction Company would publish an authentic history of the Niagara plans, and now such a publication is absolutely necessary to put an end to what is anything but a pleasant phase in engineering etiquette.

The testimony given at the trial reveals some leading facts in the history of the proceedings. In 1889 the subject was first broached, but at that time it was considered impossible to transmit the power to Buffalo by either one current or another. In 1890 a consultative committee, grandiloquently self-styled the Niagara International Commission, was formed, consisting of Lord Kelvin, Dr. Coleman Sellars, Prof. Mascart and Colonel Turrettini, with Prof. Unwin as secretary. This commission was to examine plans and award prizes; 26 plans were examined, and some use was made of 14 of them. Lord Kelvin received £500, Mascart, Turrettini and Unwin received each £400, Coleman Sellars being at the time paid at the rate of $12,000 a year. It is not stated whether anything was paid for the 14 plans made use of; presumably nothing was disbursed on that account. Two second prizes were awarded, but no first prizes; other experts and professors were paid for reports, amongst them being Dr. John Hopkinson, who stated that his charges were three guineas an hour for such work, so his little bill came to $250. Prof. Norton charged $250, Prof. Fleming £10 for a report,

and Prof. Forbes is stated to be receiving $400 a month as expenses and salary, so it will be gathered from these figures that Prof. Rowland has made by far the biggest haul out of this most extraordinary business.

If there is wisdom in a multitude of counsellors, the Cataract Construction Company have most certainly made every endeavour to obtain it, regardless of expense. These advisers have, however, been all drawn from the same class, with only one or two exceptions, a class of theorists and unpractical men, and it is simply astounding to discover that none of the engineers engaged actually in the designing and constructing of the class of machinery required by the company, have been consulted. The company seems to have pinned its faith to professors, for what reasons we cannot conceive, but we are curious to know, and by this date the company will be quite in a position to tell us, just what they got for the money spent on these gentlemen; the reports received, for the money spent, would be of vast interest and would well repay publication. It will be a strange commentary on the whole proceedings if, after all, it turns out that the Tesla system of the Westinghouse Company has been adopted *en bloc*, and that the plans finally adopted have been originated by the engineers of that company, the dearly bought plans of the professors being consigned to the oblivion of the waste paper basket. Dr. Sellars testified that Prof. Forbes had all along advocated alternating current systems, and that the present apparatus was designed by himself and Prof. Forbes, and that it was totally different from that described in Prof. Rowland's report, and a model of the dynamo as designed by Forbes and Sellars was exhibited in Court, showing it to be as they stated.

From the testimony it would appear that there is a distinction recognised between an "expert" and an "expert witness." The valuable qualifications of the "expert witness" consist not so much in the possession of actual scientific knowledge, as in his ability to bring out the strong points on his own side of the case, and in dodging the weak ones. The "expert" is a man devoid of this ability, but thoroughly acquainted with the science of the subject; but he is not of much use in the witness-box.

The matter is not ended, as an appeal has been notified; but so far as it has gone it will be seen that although the proceedings throw a side light on men of learning and culture, where money matters are concerned, the Cataract Company have paid liberally for information which they imagined was valuable for their purposes. We are afraid, however, that much of their liberality has been misplaced, just as we feel certain that Lord Kelvin, and some others whose names are associated with this scheme, would never have countenanced it, had they been aware that the electric transmission of power from Niagara was but a sprat to catch a mackerel.

ENGINES AND DYNAMOS.

Much has been written about the various combinations of engines and dynamos, and yet much remains to be done. It is quite natural to find considerable difference of opinion in regard to the various combinations, for engineers are not agreed upon the primary question as to what essential features a steam engine and dynamo combination should possess. One engineer thinks low speed the first essential; another advocates high speed; another considers the floor space occupied as of the utmost importance. The coal bill is the only thing another one imagines is of any account, and so on, and doubtless these divergent opinions will be held as long as engines and dynamos are used to generate current.

In choosing an engine for driving a dynamo, the engineer must consider many things with respect to the circumstances of the particular installation for which the engine and dynamo is to be ordered.

The questions are usually divided up into a few important ones. First, direct or gear driving, geared driving involving the use of ropes, belts, pulleys, and shafting. On this question there is no doubt whatever. Direct driving is voted by a large majority as the correct thing; it has the advantage in every respect; it is cheaper in first cost, occupies less space, runs cheaper, safer, and at less maintenance cost.

The only drawback to direct driving is that it sometimes requires a large dynamo, that is, when a slow speed engine is used driving direct. Direct driving is, however, almost universally employed with quick speed engines running from 250 to 20,000 revolutions per minute, ordinary engines at the lower rate, and steam turbines at the higher. On this point of revolutions per minute, we may venture to express our opinion that too much importance is attached to it, some electricians looking upon all rates of revolution above a certain rate as being *too high*. This is a mistake, 10,000 may be too high for an ordinary engine, but it is none too high for a steam turbine, and it is quite as easy to design a dynamo for a speed of 10,000 as for a speed of 1,000, and have it equally durable and efficient at both speeds.

Direct driving means speeds greater on the engine than that usually required on engines used for other purposes, and the question naturally arises, what form of engine is best suited for quick speeds? For the highest speeds—those over 1,000—the only engine is the steam turbine; and that engine has, we believe, a great future before it.

For medium speeds, we have the vertical inverted cylinder engines running at from 200 to 600 revolutions; these have been brought to great perfection in both types—the double-acting engine and the single-acting engine—and just at present the question as to which is the best of the two is being discussed in our columns. We rather think the single-acting engine has proved the better of the two, but we are open to be corrected on this point; at any rate, from figures given, we find that the single-acting engine is running the greater number of H.Ps. in central stations in this country. That, however, we do not take as absolute proof of the superiority of the single-acting engine for the purpose. A majority of the single-acting engines in central stations in England and Scotland have been put in on the advice of one consulting engineer, so that the number in use is no criterion of the general opinion among other engineers regarding their employment for central stations.

Still, there can be no gainsaying that Willans in this country, and Westinghouse in America, have made a wonderfully perfect engine of the single-acting type. These engineers, at an early date, produced a motor to meet the requirements of electricians, while other engineers were

looking to the electricians to make dynamos to suit their engines.

The advocates of the double-acting direct driving engine have to explain away the fact that the single-acting engines of Willans, Westinghouse, Chandler, and a few minor makers, run between them about 75 per cent. of the electric lighting in this country and in America.

Gas engines have been tried coupled direct, but not with much success; the speed has been too low; gas motors are mostly single-acting, and could be run up to much higher speeds if built on the same lines as quick speed steam engines, but many gas engine designers do not seem to be able to get away from the horizontal type with the absurd overhanging cylinder. Why they did not design a vertical inverted cylinder engine is an unexplained mystery. Recently, we believe, one maker has brought out one of this design, which has been made in small sizes.

Water turbines are usually coupled direct when used for dynamo driving. For this purpose the Vortex turbine, invented by the late Prof. James Thomson, brother of Lord Kelvin, has many advantages, and is used to a very large extent on this side, while in America the exceedingly simple Pelton wheel is largely employed.

Wind engines or wheels have been studied for some years by Prof. Blyth, of Glasgow, and we believe he has obtained some encouraging results, using a wheel made up like Robinson's anemometer on a large scale. The axis of this wheel is vertical; the wheel does not, therefore, require shifting as the wind shifts, like an ordinary windmill wheel, and it does not race dangerously in a gale. Using accumulators and a dynamo which runs at variable speeds, such a wheel could be left for long periods to itself.

We hope the discussion on the steam engine question will bring forth some definite results, and tend to settle some of the contested points between the advocates of the single-acting and double-acting engine.

The question of direct *versus* gear driving is also open to discussion, but we think the arguments in favour of direct driving are quite conclusive. Rope driving is resorted to for the purpose of getting up speed on the dynamo, but it is better to compromise and use a direct driven dynamo at less speed, coupled to an engine at a higher speed.

Magnetic Shielding.

Special interest has of late attached to the problem of shielding magnetic forces by means of iron screens, and amongst other instances where it has been successfully solved may be noted the protection of the absolute magnetic instruments at Greenwich from the disturbances due to a dynamo. In this case external space was protected against magnetic forces produced inside the enclosure. The converse, however, is sometimes adopted, and, as in Lord Kelvin's marine galvanometer, instruments are enclosed in iron and thus protected against external magnetic influence. In the particular case when the iron shields are spherical shells, the method of attacking the mathematical problem involved is well known. Maxwell gives the working in the case of an internal space protected by a single shell, and also discusses the precisely analogous problem of the flow of currents interrupted by shells of different conductivity from the rest. There are, however, a number of facts of some importance which are not generally known, and these are dealt with by Prof. Rücker at great length in the *Phil. Mag.* for January. The principal point to which attention is directed is the calculation of the advantage gained by lamination, that is, by using shields separated by air-gaps, instead of a continuous mass of iron. That lamination would be useful might be foreseen by the aid of the hydro-dynamical analogue to the magnetic field. If we suppose sources and sinks of equal power to be placed within an enclosure, we may weaken the flow outside, either by making the enclosure, or part of it, very permeable, or by making the bounding surface very impermeable. In like manner in the magnetic problem there are two ways of reducing the internal field, namely, by enclosing the central region by shells of greater, or by shells of less permeability than the surrounding space. Although, in practice we cannot use any material of less permeability than air, we can introduce into an iron shell layers of material less permeable than itself. These may tend to reduce the external field by preventing, as it were, the force from penetrating to the external shell. This analogy has long suggested that laminated shells, in which both the permeability of the iron and the relative impermeability of other materials are utilised, may be the most effective shields; and we are thus led to enquire which is the best arrangement that can be made under specified conditions as to the magnitude of the space at our disposal, or as to the weight of the shielding material used. The answer to this question is supplied by the mathematical discussion in Prof. Rücker's paper. As the formulæ are somewhat heavy he confines himself to the consideration of shells formed of the same material and separated by air-gaps. The second problem to which Prof. Rücker calls attention is that which defines the relations between the shielding exerted by a number of concentric shells (1) on the external space when the magnetic forces are produced within the shells; and (2) on the enclosed space when the magnetic forces are produced outside. A full discussion of this is given. The whole investigation is subject to three limitations, viz.: 1. To concentric shells; 2. To cases in which the equi-potential surfaces are surfaces of revolution about a line through the common centre of the shells; 3. To the case in which the permeability of each shell is constant. As regards the first two of these, the conclusions arrived at are capable of generalisation in such a way as to enable a better approach to be made to good shielding arrangements than would be the case if the results of the discussion in the simple case of spherical shells were unknown. The third limitation, no doubt, affects the applicability of the formulæ to practice; but in spite of this Prof. Rücker ventures to think that they afford some useful guidance, and that, at all events, they help to put the practical problem in definite terms. Prof. Rücker's paper was originally read before the Physical Society a few weeks ago, and is now reprinted in the *Philosophical Magazine*: here it occupies upwards of 30 pages, which will amply repay careful study.

Transformers.

The theoretical investigations of Messrs. Bedell and Crehore into the question of the alternate current transformer have been recently put to the test of experiment by the former. A transformer was made with a magnetic circuit whose reluctance could be varied between certain limits, and an investigation was entered into on the lines of their previous paper. The curves got from these are very much like those arrived at theoretically under the assumption of sine currents and E.M.Fs. and constant induction co-efficients, so that it would appear that with ordinary transformer inductions, the above assumptions are sufficient for a first approximation in the mathematical treatment of iron-cored transformers as well as those with air cores.

HOW NOT TO DO IT.

There may be wisdom in a multitude of counsellors, but the advantage ascribed to numbers and variety is certainly absent if applied to the plant of a street railway, and although such a misapplied precept may delight the critic, it is not conducive to secure the desirable degree of safety.

A certain street railway plant, which is described by Mr. J. B. Cahoon in a recent number of the *Electrical World*, of New York, furnishes an illustration.

If a firm of carriers were trying to utilise for the purposes of their business a stud composed of a number of light and heavy horses, intermingled for the sake of still greater variety with a few mules and asses, all intended—it must be understood—for the same class of work, the wisdom of such a policy, and the probable results, may be expected to stand on about a par with those prevailing in the case of the street railway depicted in the above article.

The original plant, which consisted of engines of 200 H.P., boilers of 500 H.P., and generators for 160 units, was evidently not enough for the satisfactory and reliable working of 20 motor cars, for although 10 H.P. may be considered sufficient, under normal conditions of the road, on a practically level track, such as the line under consideration presents, yet no provision is made either for the excess of power required in the case of several cars starting simultaneously, or what is more important still, for part of the machinery being disabled or under repair.

Electrical engineers agree that with 20 motor cars running, the plant, including surplus, should comprise 20 to 25 H.P. per car, or 400 to 500 H.P. in all.

At the end of the year the number of motor cars was increased to 40, and the plant at the generating station now affords a vivid picture of variety. The original 200 H.P. engines were of the Westinghouse make and non-condensing. The new additions comprise a Cooper-Corliss tandem compound condensing engine of 380 H.P., and two 350-H.P. tandem compound condensing Buckeye engines. There were also in the first instance four 125 H.P. boilers fitted with mechanical stokers. To this were added three horizontal boilers of 100 H.P. each, and two Manning upright boilers of 250 H.P. each, besides one 1,000 H.P. Worthington jet condenser, and one 1,000 H.P. Hall's live steam purifier. As for pumps, we have one Epping boiler feed pump, one Blake duplex boiler feed pump, one Worthington duplex pump, one Hancock inspirator, and one Metropolitan inspirator.

The electrical equipment consists in addition to the two original Rae generators of 80 units each, of two Edison generators of 150 units each, one Westinghouse generator of 300 units, and of a 1,000-light alternator, and a 50-light 2,000 candle-power machine, the last two for the lighting of the power station, car sheds, &c.

Summing up, the total horse-power of the engines is 1,280, the aggregate of five engines representing three different types; the boiler power amounts to 1,300, the aggregate of nine boilers representing, also, three different types; and the generator power to 840 units, the aggregate of seven dynamos and five different types. The average daily output required for running the 40 cars is given as 400 ampères, but no mention is made of the voltage, which we assume to be about 500; there are, of course, the usual fluctuations, rising for short periods to double the normal output. That the mechanical stokers should fail to work satisfactorily, owing to the underpaid firemen not taking kindly to them, can hardly be constituted into a charge against the former, but with the existing arrangement of feed water and the manner of firing, boilers priming badly necessitating a further complicated arrangement, it is not surprising that the consumption of fuel should be excessive, amounting to 5·47 lbs. of good steam coal per horse-power hour.

To form what may be called by courtesy a duplicate plant, recourse was had to a most elaborate but less simple or reliable arrangement of shafts, countershafts, and belting. The task to so arrange the different types that they should be interchangeable must, indeed, have been a difficult one.

Altogether, from the description of our contemporary, it appears that this is one of those installations which may serve as a warning, showing how things should not be done.

The first class electrical engineer whose services it is anticipated might save the property from bankruptcy, will find all his work cut out for him; one of the greatest difficulties in such cases consists in convincing the proprietors that the greater part of the existing multifarious plant must be disposed of at a heavy sacrifice to make room for its more efficient and more uniform successors.

THE CAPACITY OF LOOPED CABLES.

By ROLLO APPLEYARD.

"The capacity of a loop formed of two equal cables, no 'earth' being used, is half that of one of the cables using an earth return." This relation is, perhaps, self-evident; the following considerations may, however, be of interest to those who have not proved its accuracy for themselves.

The capacity of a cable is generally tested with the distant end insulated; when fully charged, under these conditions, the potential throughout the entire length is uniform. In actual working the further end is not insulated, but is connected through conducting apparatus, either to earth, or by a return loop, to the sending station; in place of the uniform potential, there is now a steady fall from end to end. Consequently, the static charge given to a cable during the ordinary capacity test, is twice the static charge held by the same cable when a battery of equal P.D. to the testing battery is sending a steady current through the cable. Neglecting all resistances except the cable conductor, the two cases are represented in figs. 1 and 2.

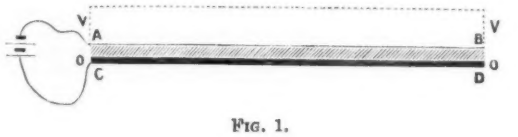

Fig. 1.

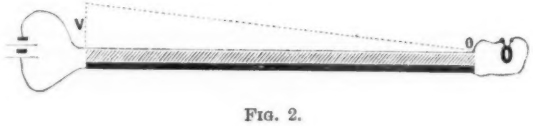

Fig. 2.

In both conditions the capacity of the cable is, of course, the same; but the actual static charge has to be determined from the mean potential along the conductor, A, B; which in the first case is V, and in the second $\frac{V}{2}$. The corresponding charges are, respectively, KV, and K $\frac{V}{2}$; K being the capacity of the cable.

Apart from all difficulties of magnetic induction, it is clear that the arrangement shown in fig. 2 cannot properly be replaced or exemplified by a simple condenser; a rough comparison may, however, be made between such a cable and a condenser having its plates connected by a specially wound compensating coil, as shown in fig. 3.

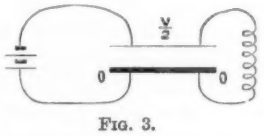

Fig. 3.

The P.D. between the two plates must be taken as $\frac{V}{2}$. Other things being equal, the capacity of such a condenser would still be inversely proportional to the distance between the opposed plates.

Consider, now, the practical case of a loop formed of two

equal cables, connected together at the distant end, no earth being used. This is represented in fig. 4. The sheathing wires and water are shown diagrammatically by E, E, which may be supposed to have any thickness whatever, or may take any form ; the only condition being that the two conductors, F and G, must be everywhere separated from E, E, by a dis-

Fig 4.

tance equal to the thickness of the dielectric of the cable. Or E, E, may be removed altogether ; the cores would then lie in contact throughout their entire length. From this it is evident that, in the case of looped cables, the water and sheathing is simply a conducting go-between, filling up the space between the two dielectrics, thus keeping the capacity constant whatever may be the relative distances or positions of the two cables in the water, the essential condenser action occurring between the two copper conductors. This is analogous to the condenser shown in fig. 5, where the

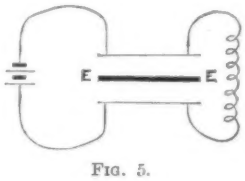

Fig. 5.

sheathing wires are represented by a conducting sheet interposed between the two plates. So long as the dielectric thickness in such a condenser remains constant, any change whatever can be made in the form or thickness of the interposed conductor, E, E, without affecting the capacity of the arrangement.

As regards *capacity*, the case given in fig. 2 is different to that of fig. 4 only in the thickness of dielectric separating the effective conductors (which in fig. 2 are wire and earth, and in fig. 4 wire and wire) ; and since in the second case this thickness is double that of the first, the capacity of the loop formed of the two equal cables, no earth being used, is half that of one of the cables using an earth return. The *resistance* of the looped arrangement is, of course, double that of the single wire and earth, which makes the "K R" equal for both systems.

RELATIVE COSTS OF DISTRIBUTION BY DIFFERENT ELECTRICAL SYSTEMS WITH THE SAME EFFECTIVE OR MAXIMUM E.M.F.*

By A. E. KENNELLY.

In Mr. Weaver's interesting article upon this subject, appearing in the *Electrical World* for January 13th, page 48,† two of the conclusions reached appear open to some modification.

1. In the deduction by aid of figs. 5, 6 and 7, that the triphase and diphase systems require equal weights of conductor when equal effective delivery pressures are employed, it is evident that this applies only to the delta triphase system. If the diagram of a Y triphase system be exchanged for fig. 7, the effective pressures, as measured at the lamps, will be the same as before, but the current in each main conductor will be 2 ampères instead of $2\sqrt{3}$.

This arrangement will cause the delivery to the six lamps to be accompanied by a loss in the mains of $3 \times 2 \times 2 = 12$ watts, introducing, therefore, a saving of 75 per cent. in the copper needed for simple alternating current distribution.

On the basis of maximum E.M.F. between conductors this difference between the Δ and Y varieties of the triphase system does not appear.

2. There appears to be a flaw, although from a practical point of view an insignificant one, in the result quoted in Mr. Weaver's article for the diphase system. Fig. 6, page 48, represents three equal wires carrying three currents that are not all equal in strength. From the examination of any exaggerated case of this nature, it becomes evident that the purposes of economy can best be served by apportioning the total copper unequally among unequal currents. In this case, suppose each wire to weigh 100 lbs., making 300 lbs. total weight. Then it follows arithmetically that the most economical division of this copper gives 87·9 lbs. to each outside conductor (resistance 1·138 ohm), and the balance of 124·2 lbs. to the return wire (resistance 0·805 ohm). The loss in delivery will now be $2 \times 3 \times 3 \times 1{\cdot}138 + (3\sqrt{2})^2 \times 0{\cdot}805 = 34{\cdot}97$ watts, instead of 36, making the relative copper expenditure 291 lbs. instead of 300. This appears to agree with Mr. Kapp's estimate.

Summing up, then, on the basis of Mr. Weaver's results, with the above slight modifications, we have for the relative loss of energy in the same weight of conductor on the different systems, or for the relative expenditure of copper for the same loss in transmission by the different systems :—

	On basis of equal Effective E.M.F. at translating device.	On basis of equal Maximum E.M.F. between conductors.
Continuous current metallic circuit	100	100
Simple alternating current (metallic circuit)	100	200
Diphase with common return wire..	73	291
Triphase, Y system	25	150
Triphase Δ system	75	150

To these may be added other well-known systems for the sake of comparison :—

	On basis of equal Effective E.M.F. at translating device.	On basis of equal Maximum E.M.F. between conductors.
Continuous current three-wire, allowing 60 per cent. of outside copper to neutral wire	32·5	...
Five-wire continuous current system, allowing also 60 per cent. of outside copper to inside wires..	11·9	..

THE SAVING OF COPPER IN THE THREE-WIRE THREE-PHASE SYSTEM.*

By Dr. LOUIS BELL.

Within the last few months this subject has received attention from nearly every electrician of repute who is in the least interested in alternating work. Up to date the discussion has been entirely on theoretical grounds, and, indeed, this is all that is really necessary, since we may take Ohm's law for granted, and the mathematical processes involved in the necessary computations are neither difficult nor complicated. The results which have been reached are in substantial accord on the point that there is in the inter-connected, or three-wire three-phase system, a saving of 25 per cent. over the copper required, all other conditions being equal, by the single-phase or any polyphase system employing a complete circuit per phase. Inasmuch, however, as an experimental demonstration speaks more clearly to the mind of the average man than any amount of theorising, I have recently performed some experiments for the purpose of satisfying those unfamiliar with mathematics, or stubbornly unwilling to accept mathematical demonstrations, with the exact facts in the case. The experiments were of the simplest possible character, consisting of the transmission of energy over a three-wire three-phase line and a single-phase line, under conditions that could be most carefully controlled. Four

* We are indebted to the editor of the N.Y. *Electrical World* for advance proofs of this communication.

† Electrical Review, January 26th, 1894.

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non-inductive lines of equal length were set up leading to a small bank of lamps. The four wires were then arranged two in parallel, and single-phase current at 50 cycles per second transmitted over them, the voltage at the dynamo and at the lamps and the amount of energy being carefully noted. This terminated the first part of the demonstration. Next, one of the four lines was removed and the three remaining lines used to transmit three-phased current at 50 cycles to the same bank of lamps connected in the mesh combination. The next result was as follows:—With the same initial voltage and the same energy transmitted, the same loss of energy was observed with the three-phase system and three wires as had previously been found with the single-phase system and the four wires. In other words, the same amount of energy was transmitted at the same loss with three-quarters the weight of conductor. The agreement with the theoretical saving of 25 per cent. was within 1 per cent., sufficiently close to render the demonstration complete. Now let us see what this really means; it signifies that by the use of the inter-connected three-phase system we can transmit the same energy with the same loss as in the single-phase system, using but three-quarters the amount of copper. Or it means that with the same amount of copper we can transmit more energy with the same loss, or the same energy at a higher efficiency. So far as the economy of the system is concerned, the inter-connected three-phase circuit is equivalent to a rise in voltage of about 15 per cent., without, however, introducing the added strain on the insulation that would be met if the voltage of the generator were actually raised 15 per cent.

To deny the saving in the inter-connected three-phase system, therefore, is equivalent to denying any advantage in increased voltage. No matter by what process the amount of copper required to meet given conditions be computed, whether by an assumed drop on the line or by rigid application of Lord Kelvin's law, the fact still remains that the three-phase system has 25 per cent. advantage over the single-phase system in the intrinsic amount of copper required to do the same work. It might be desirable in special cases not to let this saving appear as a decrease in the cross-section of the copper, but to take advantage of it in increased output or in increased efficiency. Whatever the character in which the saving in copper may appear, it is always existent, and although a jesuitical attempt to conceal it may suppress it in a certain particular function, it will always appear somewhere and somehow as an absolute saving in the transmission system, just as will be the case with a genuine increase of voltage, and he would indeed stultify himself who would attempt to conceal the advantage of increased voltage in the electrical transmission of power.

A NEW RESISTANCE MATERIAL.

Some time ago, a new resistance material was introduced by the firm of Krupp, of Essen, which has not only a very high coefficient of resistance, but also is remarkably well adapted for being worked into the forms required in practice. Some interesting experiments carried out with this material by G. Dettmar are described in the *Electrotechnische Zeitschrift*, of December 15th. The coefficient of resistance of Kruppin (the name proposed for this new material), showed at first considerable variations, but these were found to depend on the hardness of the wire. For hard wires, values were obtained from 0·71 to 0·76, for soft wires from 0·81 to 0·85. It was found that there was no further change of the resistance after the material had been once annealed.

The following results were obtained from experiments with a 0·6 mm. wire:—

Condition of the wire.	Resistance in ohms.
Hard	2·670
Annealed once	2·836
„ twice	2·844
„ three times	2·840

The annealing was effected in this case by a sufficiently strong current.

The mean of a large number of experiments gave the coefficient of resistance of the annealed material as 0·83.

Experiments were made to determine the variation of the resistance with the temperature by suspending a spiral of 1 mm. wire in a petroleum bath, which was heated to the required temperature by a second spiral surrounding the one to be tested, and heated by a regulated current. The bath was kept at a uniform temperature by constant stirring. The resistances were measured by simultaneous potential and current measurements, the current being applied for a short time, and so small as not to heat the wire perceptibly.

The measurements extended from 74·5° C. to 15·1° C., and the following results were obtained:—

Temperature.	Resistance.
74·5	2·61
69·5	2·59
69·0	2·59
59·4	2·58
59·0	2·57
50·1	2·55
50·05	2·52
40·1	2·51
28·85	2·46
15·1	2·43

From these numbers a mean temperature coefficient of 0·0013 is obtained.

By far the most important applications of a resistance material is in the form of spirals. These applications may be divided into two groups, namely, continued and momentary.

The following tests were made with a view to these two applications. The spirals tested were normally ventilated as in ordinary practice, and where this is not the case the results given must be correspondingly altered. In abnormal cases, however, it will be necessary to determine only a few values, and interpolate by means of the results given.

Since the way in which a spiral is wound has an extraordinary influence upon the load which it will carry, it is necessary, in the first place, to determine the effect of the two essential factors, namely the pitch of the windings and the diameter of the spirals.

To determine the influence of the pitch of the spirals, several spirals of equal diameters, but of different numbers of turns per decimetre of the spiral's length, and of different thicknesses of wire, were examined. As a mark for comparison the "hissing point," described later on, was employed.

Spiral 1.

(*Diameter of spiral* 12 *mm. Thickness of wire* 2·2 *mm.*)

Turns per decimetre of length of spiral.	"Hisses" with c ampères.	Number of watts absorbed per decimetre of length of spiral.
0	12·4	3·24
5·1	12·0	5·48
10·4	11·0	9·45
15·4	9·4	10·60
20·5	8·0	10·00
26·3	6·8	9·25
31·1	5·9	8·52
35·6	5·5	8·00

By setting these values out as a curve, it can be seen that the spiral has its greatest efficiency when there are 15 turns per decimetre of length of the spiral.

Spiral 2.

(*Diameter of spiral* 12 *mm. Thickness of wire*, 1·0 *mm.*)

Turns per decimetre of length of spiral.	"Hisses" with c ampères.	Number of watts absorbed per decimetre of length of spiral.
25·8	2·7	8·4
29·8	2·6	9·3
35·0	2·45	9·6
41·4	2·25	9·4
50·5	2·0	9·0

The maximum efficiency is here obtained with 35 turns per decimetre of the length of the spiral.

From these and a number of other experiments, the result was obtained that a spiral of 13mm. diameter is most efficient

when the distance between two turns is equal to twice the thickness of the wire.

The influence of the diameter of the wire is shown by the following experiments :—

Spiral 3.

(*Diameter of spiral* 18 *mm. Thickness of wire* 2·3 *mm.*)

Turns per decimetre of length of spiral.	"Hisses" with c ampères.	Number of watts absorbed per decimetre of length of spiral.
11·5	9·5	14·4
13 5	9·4	16·4
18	8·9	19·5
23	7·7	19·0
31	6·5	18 2

This spiral is most efficient with 18 turns per decimetre. The current permissible is 8·9 ampères, while with the 12 mm. diameter spiral the permissible current was 9·4 ampères.

Experiments were made with a coil 6·0 mm. diameter, but it was found that the maximum absorption required the turns to be so close together that there was danger of contact.

The general conclusion from the above experiments is, that the current which a spiral will carry, depends essentially on the pitch of the turns. In a much less degree it is influenced by the diameter of the spiral after the best pitch has been arrived at.

In the following experiments on the loading of spirals, only such are used as fulfil the above conditions of maximum efficiency. These are called "normal" spirals. The diameter of the spirals was in every case 12 mm.

If the diameter of a spiral does not differ much from the spirals 2 and 3, the values given below can be used. It remains only to determine the best pitch of spiral in the required case, which may be determined by a single series of experiments.

Spirals for Continued Loads.

If a sufficiently hot spiral is touched with the moistened finger, there is, in consequence of the sudden evaporation, a characteristic hissing sound. In the foregoing experiments, to obtain comparative results, the currents were measured which brought the spiral to the hissing point. The values so obtained are assumed to be the continued or time loads.

For different thicknesses of wire these hissing currents can be calculated approximately from the following formula—

$$i = 2{\cdot}7 \sqrt{d^3} \qquad (1)$$

where i is the current and d the diameter of the wire in mm.

This formula agrees with experiments very exactly for wires over 1 mm. in diameter.

Spirals for Instantaneous Loads.

The moment when dull redness commences is taken as the standard for comparing wires of different thickness. On this principle, the times required in the case of single wires to produce dull redness were determined. The following is one series of experiments :—

Time required, minutes.	Current for dull redness, ampères.
5	40
1·75	46
1·25	50
·92	55
·6	63
·416	71
·315	78
·270	90

These values may be used to set off a curve.

Other values may be obtained by the following formula—

Let i_1 be the permissible current for the time t_1,

" i_2 " " " " " " t_2,

then

$$\frac{i_1^4}{i_2^4} = \frac{t_2}{t_1} \qquad (2)$$

There is a good agreement between the observed and the calculated values for times, from ·3 to 2·5 minutes.

For completeness, another formula may be given for calculating the permissible current for a one minute application. If i be the permissible current, and d the diameter in mm., then

$$i = 6{\cdot}7\ (d)^{\frac{1}{2}} \qquad (3)$$

From formulæ (2) and (3) another may be obtained for the calculation of the currents for instantaneous loads and different times of application.

$$i = 6{\cdot}7^4 \sqrt{\frac{d^4}{t}} = 6{\cdot}7\ d \sqrt{\frac{d^3}{t}},$$

this holds for $t = 0{\cdot}3$ to $2{\cdot}5$ minutes.

In the above formula i signifies the permissible current for the time, t minutes, d being the diameter of the wire in mm.

Experiments were also made with spirals wound on earthenware cylinders. The wire could then be raised to a higher temperature without risk of deformation. The cylinders had an outer diameter of 85 mm., a length of 225 mm., and 55 grooves. The same relations held between time and current as with the spirals. Formula (2) was valid for times from 0·6 to 8 minutes.

In the following table all the results are collected together. It must not be forgotten that the results are for spirals with the most efficient pitch of windings.

Diameter of wire.	Resistance in ohms per metre.	Length in metres per ohm.	Spirals.		On earthenware.	
			Time load.	1 minute load.	Time load.	2 minutes' load.
0·5	4·23	0·2365	1	2·0	3	6
0·6	2·93	0·3420	1·5	2·7	4·5	9·0
0·8	1·657	0·6040	2	4·5	7·0	15·0
1·0	1·058	0 9470	3	6·5	9·0	20·0
1·2	0·735	1·362	3·5	9·0	11·0	24·5
1·4	0·539	1·855	4·5	12·0	13·0	28·5
1·6	0·413	2·422	5·5	15·5	14·5	31·5
1·8	0·327	3·063	6·5	19·0	16·5	35·5
2·0	0·264	3·790	7·5	23·0	18·0	37·5
2·3	0·200	5 00	9·5	29·5	20·0	41·5
2·5	0·169	5·92	10·5	34·0	21·2	43·5
2·8	0·1344	7·43	12·5	40·5	22·7	46·5
3·0	0·1175	8·52	14·0	45	23·5	48·5
3·5	0 0862	11·60	17·5	60	...	...
4·0	0 0661	15·13	21·5	75	...	...

LORD KELVIN'S ELECTRIC CURRENT MEASURER.

In this apparatus, which has recently been patented by Lord Kelvin, there are two small equal coils of fine wire rigidly connected with their central planes in one, and their wires so joined, either in series or in parallel, that the current runs in opposite directions through them. The framework carrying these coils is supported so as to be free to turn round a horizontal axis, which may be either in the line joining the centres or perpendicular to that line, and is guarded against other motions. The finest pivots in jewelled holes do not give sufficient freedom for the proper motion, and the alignment of knife-edges to rest on two planes is difficult in construction and liable to be lost by some slight strain in use or in carriage. Lord Kelvin, therefore, uses either an axe-edge supported on a central bearing plane, or a suspension on a concave knife edge and straight knife edge fixed in proper position, with the edges at their bearing points as nearly as may be tangential to, and coincident with, the axis of the proper motion, and supported by two fixed hooks, well rounded and polished, and of hard material. Two fixed coils are placed so as to act respectively on these two movable coils after the manner of the single fixed coil and the single movable coil in Weber's electro-dynamometer, but with motions round a horizontal axis, instead of round a vertical axis, as in the instrument of Weber.

To provide the electric connection for the electric current through the movable coils, two flat spiral springs, like the hairspring of a watch, but of non-magnetic metal, are used. These springs serve also for the purpose of giving return force to the movable system, varying very nearly in simple proportion to the angle of its displacement from its position of equilibrium.

Figs. 1, 2, 3 and 4 show the general arrangement of the instrument; *a* and *b* are two small coils of fine wire, which are rigidly connected by a bridge, *c*, with their central planes in one. The wires of these coils are so joined, either in series or parallel, that the current runs in opposite directions through them. The coils and framework are supported so as to be free to turn round a horizontal axis, which may be either in the line joining the centres or perpendicular to that line.

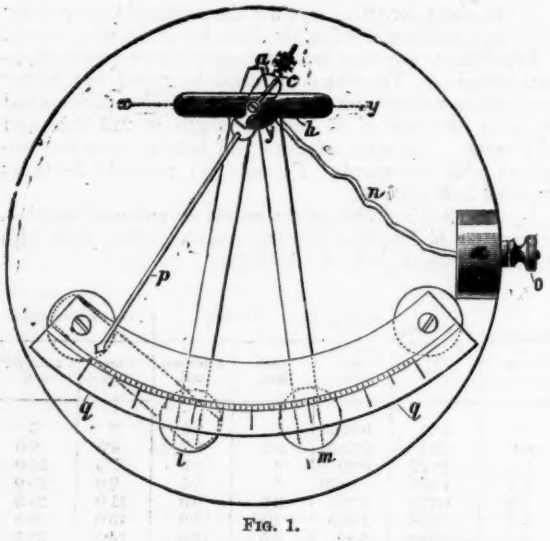


Fig. 1.

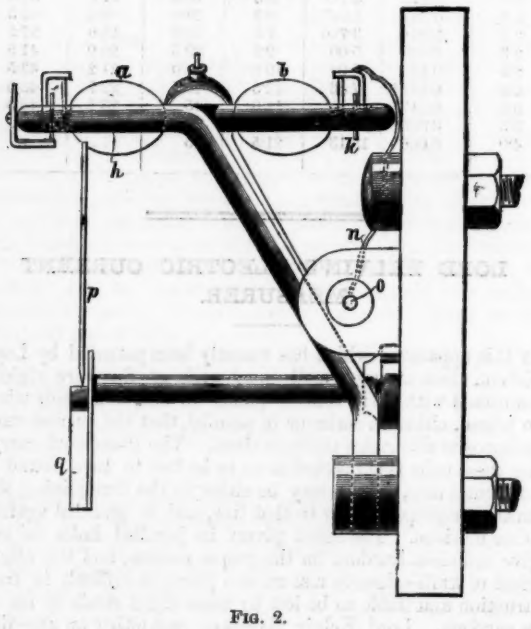


Fig. 2.

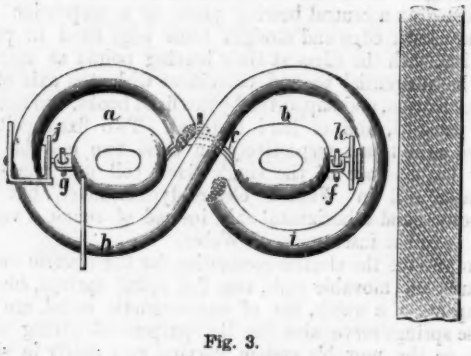


Fig. 3.

The method of supporting the coils and framework is shown at fig. 4. At one end of the framework there is a concave knife edge, as shown at *d*, and at the other end of the framework a straight knife edge, as shown at *e*. The concave knife edge and straight knife edge are supported by two fixed hooks, *f* and *g*, of hard material. The line joining the bearing points is coincident with the axis round which the coils move. Two fixed coils, *h* and *i*, are placed so as to act respectively on these two movable coils; *j* and *k* are the connecting springs. One end of each spiral spring is connected through the framework to the wire of the fine coils. These spiral springs, as before stated, serve also for the purpose of giving return force to the movable system. The ends of the fixed coil are brought down to two terminals, *l* and *m*. One end of the movable coils is metallically connected by the spiral spring, *j*, to the fixed coil, *h*, while the other end of the movable coils is insulated from the fixed coil, *i*, and is connected through the spiral spring, *k*, and wire, *n*, to the terminal, *o*. The indications of the instrument may be read by a pointer, *p*, and scale, *q*, or by a mirror.

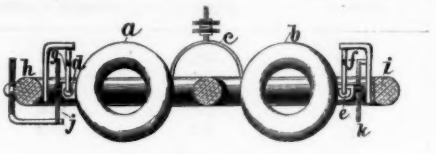


Fig. 4.

A PILLAR OF SCIENCE.*

(*Concluded from page* 107.)

Lack of space prevents us dwelling upon Siemens's eventful journeys to Russia, where his firm eventually erected some important telegraphic lines. Werner Siemens superintended the construction of Russian telegraph lines during the Crimean War. At the express command of the Russian Emperor he carried a line to Sebastopol, though Englishmen may derive a certain satisfaction from Siemens's naive remark that the line was completed just in time to announce the probable fall of the fortress. We are not wishing to suggest any comparison when we say that while Siemens was engaged in one camp, S. A. Varley—who was the subject of controversy with Siemens at a later date—was in charge of the field telegraphs of the allied armies.

Passing on to considerations of submarine telegraphs, Siemens refers to the attempt made by Brett, in 1850, to connect Dover and Calais. This line, in Siemens's estimation, was never really serviceable, and in the following year was replaced by a cable, armed with iron wires, which was laid by Newall & Co. No doubt the English Gutta-Percha Company enjoyed great facilities for coating conductors, but Siemens considers that the English needed greater skill in electrical testing to make cables successful. This may be partly true, but we do not think that "much later methods for a systematic test of the conducting wires were characterised by English engineers as scientific humbug," really represented the views of Englishmen who had at that time studied the transmission of electricity through conductors. The exigencies of telegraph work in those days precluded elaborate tests, but as an instance of rough work being successful, we may quote the instance of Messrs. Newall & Co., who, during the Crimean war, laid an unarmoured conductor from Varna to Balaclava, which remained in use till the fall of Sebastopol. Siemens says: "In this long line of about 400 miles difficulties in the matter of signalling occurred through the electrical capacity of the line, which, in spite of my publication in 1850, remained entirely unknown to the English. When the needle telegraphs employed in England refused to do their duty on the line, Newall & Co. ordered signalling apparatus from my firm, with which operations

* Personal Recollections of Werner von Siemens. Translated by W. Coupland. London: Asher & Co.

could very well be carried on. It was a singular coincidence that in the two hostile camps of Sebastopol and Balaclava, Berlin apparatus, with consecutive numbers of manufacture, were at work." It is difficult to make selections from these memoirs; mere reviewing is quite out of the question, and we abandoned the attempt after reading the first few pages. We cannot, unfortunately, dwell upon the construction of the unfortunate Red Sea cable, nor the subsequent exciting event which befel Siemens.

Then came Siemens's connection with the Atlantic cables, which, for a time, threatened dire disaster to the Siemens family. How this was eventually averted is within the recollection of many of us. Much could be said about the early history of cable enterprise from the English point of view; but this is not a fitting occasion on which to speak of it. There are other matters more or less controversial which Werner Siemens passes lightly over; in fact, throughout these "Recollections," the scientific labours is treated in a gossipy manner. For his scientific work we must go to other more serious books. We have much of the developments of the house of Siemens & Halske, and a good deal concerning the rise of the London house. Then a good deal of family matters, which are interesting, but unquotable. There is one point which Werner Siemens seems to have overlooked in mentioning the first Atlantic cable. He speaks of Dr. Whitehouse as the engineer, instead of Sir Charles Bright. This, of course, is a minor matter, for it is not to personal recollections that one would go for history. However, this is a book which is worth perusing, and we can recommend it. Mr. Coupland has translated the work in a praiseworthy manner, and Messrs. Asher are to be complimented upon the get up of the volume.

ALTERNATING CURRENT DROP.

In the *Electrical World* for January 6th, 1894, appears an article by Mr. Kennelly, on a rigorous manner of finding the voltage between the mains at the generating end or at any given point along the line, when the voltage, current, and angle of lag at the distributing end are known, taking into account the resistance, inductance, capacity, and leakage conductance of the line. Mr. Kennelly gives two formulæ for the voltage and current at the generating end in terms of the voltage, current, and lag at the distributing end, and of the constants of the line; these formulæ are based on published solutions of Mr. Oliver Heaviside; they look very simple and harmless, but as they involve vector quantities their working out in any particular case is rather a long and complicated operation, demanding a knowledge of the principles of "vectors" or "complex numbers." This Mr. Kennelly tries to supply by giving a few rules and quoting some auxiliary formulæ; we fear, however, that to the ordinary electrical engineer this will only make his "confusion worse confounded," unless he happens to be versed in vectors. It is a great pity Mr. Kennelly did not enlarge his article and go more into details, but if any of our readers wish to tackle this paper, and have no previous acquaintance with the principles of vectors, we would strongly recommend them to read first, Chapter IV., "Position," in the late Prof. Clifford's excellent little book, "The Common Sense of the Exact Sciences," and, afterwards, Part III., on "Complex Quantity" of Levett and Davidson's "Plane Trigonometry."

An example is fully worked out showing how the formulæ should be employed; the one taken is the following: "At station B, transformers are supplied at a steady pressure of 10,000 volts effective, and 100 periods, through two No. 0 A.W.G. wires of copper in metallic circuit suspended on high poles, at an inter-axial distance of two feet. The resistance of this conductor is ·508 ohm per mile; the capacity, ·081 microfarads per mile, and the leakage negligible. To find the pressure and current at A, distant 20 miles from B, when a full load of 50 ampères is sustained with a lag of 10 degrees at B."

The results obtained are that the effective (or virtual) voltage at A is 11,416 volts, and the effective current at A, 48·81 ampères, the lag between them being 13° 43′. The voltage is thus reduced from 11,416 to 10,000, or a practical loss of 1,416 volts over the mains; the actual fall over each main (as would be obtained if a voltmeter could be connected between its two ends) is 565·5 volts or 1,131 volts for the two. If the capacity were absent, the corresponding loss due to impedance would have been 1,150 volts, and the practical loss less than this, while, if a continuous current were employed, either loss becomes 992 volts. It is thus seen that the effect of the capacity is to diminish the true loss of volts over the leads, but to increase the practical loss (*i.e.*, $v_a - v_b$, not taking into account the difference in phrase).

Two figures, giving tabulated results in diagrammatic form, are appended, the one for 10,000 volts and 50 ampères, and the other for 2,000 volts and 50 ampères at the distributing end, the lag being 10° in each case; the voltages, currents, and angles of lag are given in each for distances of 10, 20 and 50 miles from the distributing end, and a comparison of the two shows how much the drop may be reduced in long distance transmission by the employment of high voltages when the current strength has a given value. It is a pity that Mr. Kennelly did not give the working out of an example where concentric mains were employed, as the capacity of these would be much greater than in the case of aerial lines.

We would finally suggest to our American contemporary that they might with advantage take a little more care in the insertion of their diagrams, even if their elaborate initial letters suffered thereby, as in the paper we have considered, one figure is conspicuous by its absence, another is printed upside down, and the numbering of three of them is wrong.

ELECTROLYSIS BY ALTERNATING CURRENTS.

To make a single-phase alternator, by means of a transformer, do work for which, in the eternal fitness of things, it appears singularly inappropriate—to make it do electro-chemical work, with a commutating device which would not ordinarily be recognised as a commutator, is a problem of which an ingenious solution comes from America. As a contemporary observes, there are three points to be attended to in attempting this problem, viz.:—

1. Send the current in the right direction.
2. Break the circuit when the E.M.F. of the alternator falls below the back E.M.F. of the electrolytic cell.
3. Make the spark consequent on the break of the circuit innocuous.

In the solution of this problem to which we refer, two electrolytic tanks are used; the currents in one direction passing through tank, A, and those in the opposite direction through tank, B. The mode in which this result is brought about will be understood, when it is stated that the tanks are of circular form; that they are divided into four compartments of quadrant shape, which we may call A_1, A_2, A_3, A_4, and B_1, B_2, B_3, B_4, that compartments A_1 and A_3, B_2 and B_4, are alone fitted with, say, negative electrodes, the remaining compartments being empty, and that at the centres of the tanks, A and B, there are vertical spindles revolving synchronously, and carrying a contact ring and the positive electrodes, which convey the current as they pass into the active compartments of the tanks, A and B, respectively. In regard to point 2, it is easy to perceive that the revolving electrodes can be covered or rendered inactive whenever the E.M.F. falls below a certain value. And, lastly, in regard to point 3, the spark produced when the circuit is broken occurs in the electrolyte, and cannot, therefore, result in the destruction of brushes and commutator.

All this is very pretty, and it will be seen that several difficulties have been ingeniously overcome. But perhaps—to borrow a saying from the great lexicographer—it would have been as well if these difficulties had been impossibilities. When we come to practical considerations, it is not so much the loss of time, amounting to 44 per cent., which, by a further exercise of futile ingenuity, may be reduced to one-half, that troubles us. No; it is rather the anode surface existent in the cases which are most familiar to us in daily work. It is the hundreds of square feet, and the difficulty of attaching them to a spindle, so that they may be brought into activity at each alternate quarter of a revolution, which lead us to the conclusion that all this ingenuity is misspent.

ELECTRICITY SUPPLY STATIONS.

No. 14.—Burnley Corporation Supply.

There are several interesting features in the Burnley Station, which has been built by the Corporation under the supervision of Mr. Thomas Parker, M.I.C.E., of Wolverhampton, as consulting engineer.

The system adopted is the low tension three-wire, distributed from a point in the centre of the town. The generating station is about a quarter of a mile from the centre, close to the river Calder, from whence a free supply of water is obtained for boilers and condensers.

An excellent building has been erected, comprising boiler house, engine room, accumulator room, offices and stores.

The boiler house contains two Lancashire boilers, by the Oldham Boiler Company, 28 feet long, 7 feet diameter, with 2 feet 9 inch flues. They are fitted with Proctor's mechanical stokers. Sufficient space is left for an additional boiler.

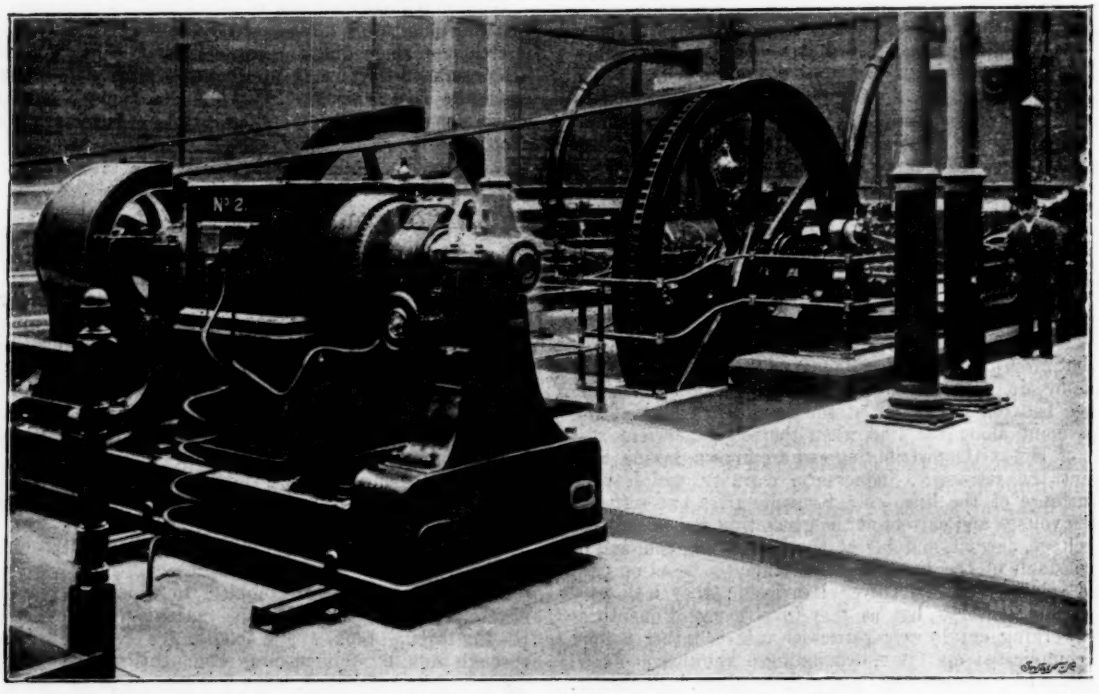
There are two feed pumps, with a duplicate set of feed pipes to each boiler, so connected that either boiler may be supplied with water from one of three different sources—from the river, from a large tank on the top of the boiler house, or from the overflow pipes of the condensers when the engines are at work. The same pumps may be used for filling the tank from the river. The steam piping is on the ring principle, so that there are duplicate ranges of pipes to reach either engine. All the fittings to the boilers are of Messrs. Hopkinson's make. There is a Green's economiser, the scrapers of which, together with the mechanical stokers, are worked by a small motor supplied by the Electric Construction Company, Limited.

The engine house is a fine lofty building, with travelling cranes overhead, capable of holding three 180 H.P. engines, and three dynamos. There are at present only two fixed, but space is available for a third, which will probably soon be wanted.

The engines are compound horizontal jet condensing, designed and built by the Burnley Iron Works Company. The condenser pump is worked from an expansion of the piston rod through the back of the low pressure cylinders. The engines are fitted with Corliss valves and an automatic trip gear worked by a governor of the high speed type. The cylinders are of 12 inches and 24 inches diameter, and the stroke is 3 feet. The engines are designed to run at 100 revolutions per minute with steam at 100 lbs. pressure. The fly-wheels are 14 feet in diameter, and weigh 6 tons each, and are grooved for 8 1¼-inch ropes.

The dynamos are built for an output of 400 ampères, 230 volts, at a speed of 450 revolutions per minute, but they are capable of doing considerably more for some time without undue heating. They are of the ordinary Elwell-Parker type, manufactured by the Electric Construction Company, fitted with automatic lubrication pumps which force the oil through the bearings. There are three bearings to each machine, the armature shaft being made with a coupling between the armature and the pulley. The dynamos are connected across the two outside wires of the three-wire mains, and the balancing is effected by accumulators and by a continuous current transformer or compensator.

The compensator is a machine of a similar type to the high tension continuous current transformer, built by the Electric Construction Company. It consists of two armature coils wound on one drum, each capable of giving an output of 200 ampères at 110 volts. These two armatures are connected



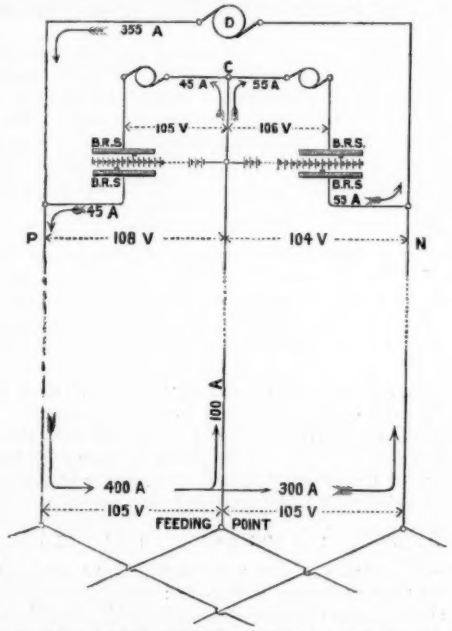
Engine and Dynamos.

in series across the three-wire mains, the point where the two armatures are connected together being joined to the middle wire. When one side of the circuit is heavily loaded, current will pass through the armature on the other side, driving it as a motor, and causing current to be generated by the armature on the loaded side to make up for the extra load. But it is obvious that the transformer will not do much work unless there is a small difference in E.M.F. on the two circuits, owing to the loss of pressure in the machine due to the resistance of the armature. The required difference in E.M.F. for various loads is as follows :—

With	9	ampères	through	generator's	armature,	0·0 volts.
"	50	"	"	"	"	1 "
"	100	"	"	"	"	1·6 "
"	200	"	"	"	"	3·4 "

In addition to this the resistance of the feeder mains causes a difficulty in working. In order that the pressure may be normal on each circuit at the feeding point, when the load is uneven on the two circuits, it is necessary to keep the pressure on the loaded side above the normal, and on the more lightly loaded side below the normal. In order to maintain 105 volts on each circuit at the feeding point, it is necessary to have, say, 108 volts across the positive circuit and

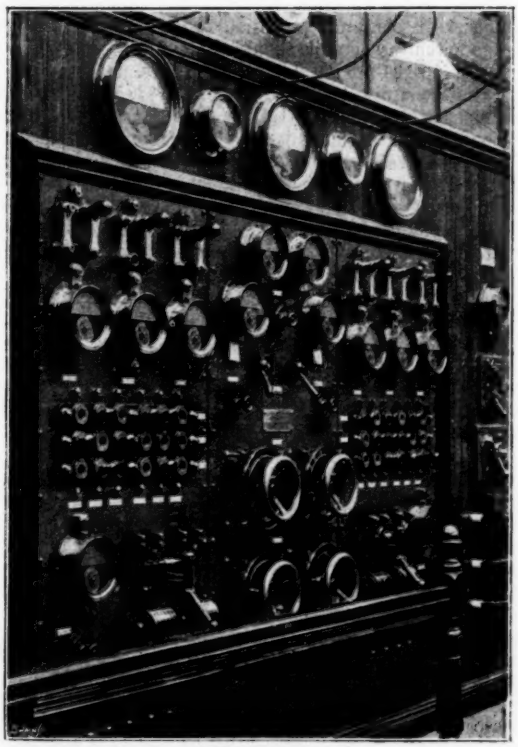
104 volts across the negative at the station. Hence, if the compensator were connected directly across the feeders at the station, it would tend to transfer energy on the side which has least load, the reverse of which is required. To overcome this one or two cells are inserted in series with the dynamo on either side of the circuit. This is effected as follows :—



A, Ampères; V, Volts P, Positive; N, Negative; C, Compensator B. R. S., Battery regulating switches.

Method of Distribution.

In the diagram there are four battery-regulating switches shown (marked B.R.S.), two for charging and two for discharging. The feeders and the dynamo are connected to



Switchboard.

the discharging, and the compensator to the charging switches. Now, if the left hand, or positive circuit, is overloaded, it is only necessary to move the discharging switches to the left and the charging switches to the right, and any number of cells are thus inserted in series with the dynamo and the transformer, and it is possible to transfer any quantity of current into the left hand circuit and at the same time to maintain the pressure constant on both circuits at the feeding point. If the right circuit is overloaded the switches must be moved in the opposite directions and the same results may be obtained. In this way it is possible to balance a three-wire system with only one engine and one dynamo running. The compensator is also of great advantage in charging up the batteries as it will always pass current into the half of the battery which is least charged up, tending to make the E.M.F. across the two half batteries even. Without it, it is impssible to charge up one battery without over-charging the other.

The battery consists of 120 E.P.S. accumulators of K 31 type, capable of giving 80 ampères for 9 hours, or 125 ampères for 4 hours.

The switchboard is of a very substantial design, built by the Electric Construction Company, mounted on slate base. It includes large sized voltmeters, which can be read from the far end of the engine room.

The mains used are Messrs. Callender's lead covered and steel armoured, buried in the ground.

The following is the approximate expenditure on the works:—Land, about £3,000; buildings, about £6,000; plant and mains, £9,500. £23,500 has been borrowed for the undertaking, at an average rate of 3¼ per cent. £4,500 for land, repayable within 50 years, and £19,000 for buildings and machinery, repayable within 25 years.

There are up to the present 3,500 lights connected to the mains.

An important feature of the station is the small staff required to work it. There are only three. The engineer in charge, engine driver, and a stoker.

It is at present only necessary to run the engine for about seven hours each week-day, even in mid-winter, the accumulators affording a supply for the remainder of the day.

DISTURBANCES IN DYNAMOS.*

By J. A. MONTPELLIER.

(*Continued from page* 87.)

16. D.—*Open circuit in the working parts of the Dynamo, or in the outer Circuit.*—When the fault is in the outer circuit, it is shown by the fact that an incandescence lamp introduced between the two terminals burns regularly, even after the principal conductors have been detached. If the lamp will not burn, the fault must be looked for in the dynamo itself, proceeding as follows :—

17. (*a.*)—*Interruption in the Circuit of the Magnets.*—We can easily find a fault of this nature by testing each bobbin separately, by means of the battery and a galvanometer or bell, arranged as shown in fig. 1; the extremities of each bobbin having previously been detached. The bobbin in which the interruption occurs would give no deflection if a galvanometer is used, or if a bell were employed instead of this instrument, it would not ring.

When each bobbin has been tested, all the connections of the circuit of the magnets must be carefully examined to see if there are any bad contacts, and these latter must be carefully cleaned.

18. (*b.*)—*Interruption in the Armature Circuit.*—The interruption of one of the bobbins of the armature may be discovered by testing each bobbin separately with the battery and galvanometer (fig. 1) after all communication has been cut off between the bobbins and the collector. If one of the bobbins, when tested under these conditions, gives no deflection, there is a break in the conductor. As this test necessitates a considerable amount of work, and consequently entails loss of time, we may arrive more quickly at the result by employing the following method: The dynamo is started, and by means of an end of wire, *a b* (fig. 4), the collector is touched at two points, *c d*, comprising between them several plates. If the machine begins to give current, a spark will be seen on the collector between the two ex-

* *L'Electricien.*

tremities of the wire, showing that the interruption occurs in the part included between the two points touched. If nothing is seen, the test is applied to other points of the collector, until the spark is produced. As soon as it appears, the machine is stopped in order to avoid any injury to the collector or the armature. The defective bobbin is then easily recognised by the signs of burning shown on the corresponding plate.

This disturbance is more often due to a bad contact than to a break in the wire of the bobbin. Defects of this kind bring about the rapid deterioration of certain bars of the collector, in consequence of the powerful sparks produced when the brushes pass over them. It is necessary, therefore, when it is seen that some bars have suffered more

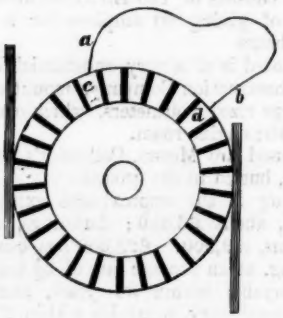


Fig. 4.

deterioration than others, to test all the connections between these bars and the corresponding bobbins of the armature, and to tighten, re-adjust, and if necessary, solder defective communications.

19. (*c.*)—*The Brushes do not rest on the Collector.*—A simple examination of the brushes will enable this cause of disturbance to be easily detected.

20. (*d.*)—*Interruption in the Outer Circuit.*—When the test indicated in section 16 shows that the fault lies in the outer circuit, we must first proceed to examine all the accessory apparatus such as interrupters, commutators, fusible circuit-breakers, joining terminals of the conductors of the principal circuit, &c., in order to see whether they are in good condition, whether the contacts are clean, whether fusible wires have been melted or are missing, whether the handles of the interrupters and commutators are in the required position, &c. This investigation should be extended to the apparatus connected with the distribution board, and also to the apparatus supplied by the distribution. To make the test more exact, we use a battery and a bell or galvanometer.

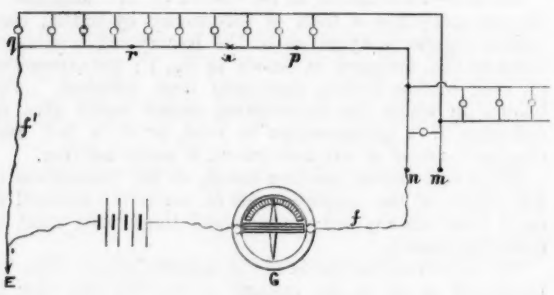


Fig. 5.

If this examination does not show the fault, we must proceed to test the principal conductors, placing the battery and galvanometer as shown in fig 5, after having opened the circuit of all the apparatus supplied.

One pole of the battery being connected to earth, and also one extremity of the conductor to be tested, the other extremity of this conductor is touched with the wire, *f*. If the conductor is not interrupted, there will be a deflection shown on the galvanometer; if there is no deflection, there is an interruption. To find the broken part, we leave the trial wire, *f*, attached at *n*, and by means of the wire, *f'*, we test a section of the conductor by attaching this latter at *p*, for instance; if there is any deflection, the section, *n p*, is in good condition, and the fault must lie between *p* and *q*. If we then place the wire, *f'*, at *r*, we find that the fault lies between *r* and *p*, and by successive tests we at length trace the fault to the smallest possible section, which is then very carefully examined.

In an installation where the various apparatus to be supplied are mounted in derivation on the principal conductors, as is the case with incandescence lamps, the working of the dynamo can only be stopped by an interruption in the principal circuit; for if an interruption occurred in any of the derivation wires, the rest of the installation would continue to work normally, and the fault would be shown by the extinction of the lamp fed by this derived wire.

21. E.—*Reversing of the Bobbins of the Magnets.*—When inductive coils have been placed on the cores in the opposite direction to the normal, or when their connections have been reversed, we find that the pole-pieces are strongly magnetised when a piece of iron is brought near each of them separately. If we test them by means of a magnet suspended freely, we see that the pole-pieces each attract the same extremity of this magnet, which shows that their polarity is of a similar nature, instead of being contrary to one another.

When the dynamo has several poles, the tests should be applied to two consecutive pole-pieces. When once the fault is discovered it can easily be remedied, either by turning the defective bobbin round or reversing its connections.

II.—Large Sparks are Produced at the Brushes.

22.—The causes which are calculated to produce large sparks at the brushes are as follows:—

A. Overloading of the dynamo:—(*a*) Abnormal voltage; (*b*) Current too great; (*c*) Bad insulation of the external circuit.

B. The brushes badly fixed.

C. The collector in bad condition.

D. The brushes and brush-holders in bad condition.

E. Interruption in the armature circuit.

F. Short-circuiting in the armature.

G. Defective insulation of a magnet coil.

H. Weakness of the inductive magnetic field.

23. A.—*Overloading of the Dynamo.*—When the dynamo is overloaded, *i.e.*, when the voltage is abnormal over a circuit with constant potential, or the current too great over a circuit where it should be constant, not only are powerful sparks produced at the brushes, but the magnets and the armature become considerably heated (see III.)

Moreover, the driving belt is stretched very light, and gives a creaking sound as it rubs along the pulley.

24. (*a*).—*Abnormal Voltage.*—This defect is shown by the voltmeter, and may be caused by the excitation being too intense or the speed of rotation too great.

The resistance is increased by means of the rheostat, in order to decrease the excitation, and as a rule this is sufficient to bring the voltage back to its normal point.

When the disturbance is caused by too high a speed, which can easily be ascertained by means of a speed-counter, the speed of the engine working the dynamo must be decreased. It may also happen, when a dynamo has just been installed and is made to turn for the first time, that the excess of speed is due to a defect in proportion of the pulley, which can easily be verified.

25. (*b*).—*Current too Great.*—In the case where the dynamo feeds arc lamps, the overload may be due to a current of too great strength. We can ascertain whether this is the case by observing the ampèremeter, and, if so, we have only to increase the resistance into the circuit of each arc lamp, by manipulating the rheostat belonging to it. If the installation comprises incandescence lamps, the overload may be due to the fact that there are a larger number working than the power of the dynamo can maintain. We have then only to suppress the lamps in excess for the working to become regular.

26. (*c*).—*Bad Insulation in the External Circuit.*—The overloading of the dynamo may also proceed from bad insulation in the external circuit, which causes a considerable increase in the strength of the current supplied by the dynamo; this frequently happens in rainy weather, when the external circuit is overhead, and consists of naked wires.

When the mains consist of insulated conductors, it is

necessary to make tests to find the point at which a derivation exists.

We first detach the conductors from the terminals of the generator of electricity, taking care that they do not touch each other, or come in contact with the wall or any metallic substance. This being done, the circuit of all the lamps is

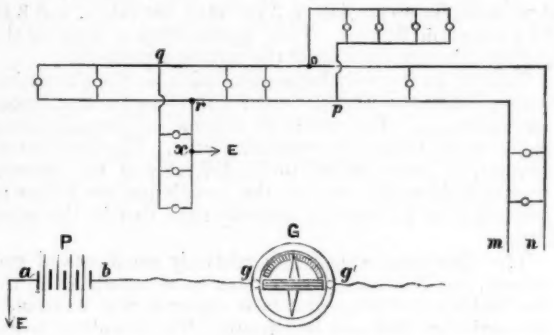


Fig. 6.

closed by means of interrupters, or a short-circuiting commutator for arc lamps. The extremities, m, n, of the principal conductors (fig. 6) being insulated, the conductor, a, is put from the battery to earth by means of a water or gas-pipe, while the other conductor, b, is connected to one of the terminals, g, of the galvanometer, G. To the terminal, g', of the galvanometer, we attach a wire for the purpose of experiment. This being all arranged, if we suppose there is a loss to earth at some point, x, of the canalisation, we shall proceed to search for it first by touching one of the extremities of the principal conductors, m, for instance, with the test wire starting from g'. If there is no derivation to earth, there will be no deflection of the galvanometer needle; if there is one, the needle will deflect. To localise the fault the conductors of all the principal derivations must be detached at $o\ p$ and $q\ r$, and either the conductor, m, or the conductor, n, must be touched with the trial wire, g'; if there is no deflection, we shall conclude that the loss is not in this circuit. We have then only to repeat the test on each of the sections, $o\ p$ and $q\ r$, to find the defective one. When this section is found, the fault can be detected by opening the circuit of all the apparatus branched on this section, and then testing separately the conductor, q, and the conductor, r. By attentively examining the defective conductor throughout its length, the fault can easily be discovered.

The fault may sometimes occur in the derivation wires which convey the current to the lamps. In this case it is necessary to detach them from the principal conductors to make the test.

27. B.—*The Brushes badly fixed.*—When the production of the sparks proceeds from the brushes being badly fixed, this can be seen by displacing the brush-holders; in this case the production of sparks varies with each displacement.

To adjust them rightly, the brushes must be moved gently backwards and forwards, until a position has been found for which the sparks are reduced to a minimum.

When this operation is not sufficient to prevent the abnormal production of sparks, we must see whether the points of contact of the opposite brushes are in the same diameter. If the brushes are not exactly opposite one another (that is, unless they are intentionally arranged otherwise by the constructor), they must be brought into their correct position. In order to find easily the points at which they should touch the collector, we count the bars, or take the measurement on each side of the space, separating the brushes from one another. If, for instance, a collector contains 40 sections, and we count as one that on which the upper brush rests, the lower brush, to be in its proper position, should rest on the 21st bar.

The correct placing of the brushes is one of the most important conditions of good working; they should bear just sufficiently on the collector with a slight spring. If they press too hard, both collector and brushes are worn out unnecessarily. If they do not press hard enough, the brushes will jerk, and sparks will be produced.

We must take care that none of the wires or plates of the brushes are turned the wrong way; that the brushes rest flat upon the collector; that they are all held in their supports at the same length; that they and the brush-holders are perfectly clean; that these latter are quite steady, and that they can work freely.

The points of contact of the brushes with the collector should always be those which give rise to sparking least. At the same time, we must remark that these points vary with the strength of the current supplied.

28. C.—*Bad Condition of the Collector.*—The bad condition of the collector may also cause an abnormal production of sparks.

To find out whether the disturbance is attributable to this cause, we must first see that the collector turns round well, and has no inequalities on its surface. If the surface is uneven when the brushes come against any hollows, they are shaken, and the contact becomes defective. A careful examination of the collector, which should be turned slowly, will enable us to see whether it is eccentric. If the disturbance is due to this cause, the collector must be turned on the lathe, either by placing a little turning lathe in such a position that the operation can be performed on the spot, or, if this is not possible, by taking away the armature and placing it on the lathe. The inequalities on the surface of the collector may be caused by scratches produced by the sparks, or by the displacement of the metal bars, which either project or sink in. By placing the finger lightly on the collector while it is turning, we can feel the slightest unevenness. When the dynamo is working at high tension, to avoid any risk we can touch the collector lightly with a little wooden rod.

If only slight inequalities are found, they may be effaced with *glass paper*; emery paper must on no account be used. If this operation is insufficient, a file must be used, taking care, however, to remove all the filings, which might occasion an accidental short-circuit between the bobbins of the armature. This work can only be performed by an experienced workman; for, if it is badly done, the collector would no longer be round, which would aggravate the disturbance. Lastly, if the inequalities in the surface of the collector are due to abnormal wear, caused by excessive friction with the brushes, we must, if they are considerable, have recourse to the lathe.

29. D.—*Bad Condition of the Brushes and Brush-holders.*—If these parts are in bad condition, the result is that there is a defective contact between the collector and the brushes, and consequently numerous sparks are produced.

A careful examination of the brushes will show whether they press sufficiently on the collector with a slight spring, whether any wires or plates in any of the brushes are turned back, whether each of them rests flat on the collector, whether they are perfectly clean, and whether they are held firmly in their holders.

When once the cause of the disturbance is known, it can easily be remedied, either by adjusting the brushes, or by cleaning them (see section 28).

30. E.—*Interruption in the Armature Circuit.*—Powerful sparks are produced on the collector, not only when the dynamo is turning at its normal speed, but also when the speed is considerably lessened. This enables us to distinguish a disturbance due to this cause from one which proceeds from the bad condition of the collector; that is, if the inequalities in the surface of the collector are not too great, and if this is the case, it can easily be seen. Moreover, the dynamo gives no current, which case has already been discussed (see section 18).

The interruption is generally produced at that point where the armature wires are connected with the different segments of the collector. What we have to do, therefore, is to test all the connections between the segments and the corresponding bobbins of the armature, and to tighten, re-attach, or, if necessary, solder the defective connections. When connection cannot be immediately re-established, the defective segment is connected with the next, and the dynamo can then go on working.

When the interruption occurs in one of the bobbins, the defective bobbin must necessarily be unwound, and wound again when the break has been mended. If it is not convenient to stop the dynamo, it can go on working when the segment corresponding to the defective bobbin has been connected with the next segment. To find out in which bobbin

the interruption occurs, we must proceed as described in section 18.

31. F.—*Short-circuiting in the Armature or in the Collector.*—This fault is easily detected by the fact that every time a brush passes over the segment connected with the short-circuited bobbin a powerful spark is produced, which burns the metal. Moreover, the dynamo gives no current (see section 12).

When this disturbance is caused by particles of copper adhering to the insulating material between two consecutive bars of the collector, all we have to do, as shown in section 18, is to find out the part and carefully clean it.

If the short-circuiting is in the winding itself, we must look for the faulty part. As a rule the bobbin containing the short circuit is easily detected by its abnormal heating, which increases until sufficient to burn through the insulating material. Therefore, when it is necessary to start the dynamo in order to localise the short circuit, we must proceed with the greatest caution, taking care to stop it after one or two minutes, to begin again a few moments after, until the defective bobbin has been detected by its abnormal heating.

A safer, but much longer method, is to measure the resistance of each bobbin ; but to do this, one must have at one's disposal a special apparatus, *i.e.*, a resistance box with a Wheatstone bridge, a galvanometer, and a battery.

When the short circuit is inside a bobbin, it must necessarily be re-wound, and if it is imperative that the dynamo should continue to work, the defective bobbin can be suppressed by directly connecting the two segments of the collector with which its two extremities communicate.

32. G.—*Defective Insulation of one of the Magnet Coils.*—This fault can be detected by the fact that, if the excitation is stronger in one of the magnets than the other, one of the brushes will give more sparks than the other, and these sparks will be produced as in the case of bad fixing. The fault must be looked for by the method described in section 9.

33. H.—*Weakness of the Inductive Magnetic Field.*—On bringing a piece of iron near the pole pieces, we find that they are only slightly magnetised. Moreover, the point at which the brushes give the minimum of sparks is constantly displaced owing to the relatively powerful action of the magnetism of the armature, and the dynamo cannot attain its normal electromotive force. The cause of this disturbance may be a break in the circuit of the magnets, or short circuiting or bad insulation of the magnet coils.

The breaking of the circuit in the magnets will be ascertained by proceeding as shown in section 17. The existence of a short circuit in the inductive circuit can be detected by measuring the resistance of each bobbin, or by employing the method described in section 11.

As a rule, the short-circuiting only affects one bobbin, so that the weakening of the inductive field is more marked on one side than on the other, and a piece of iron placed at an equal distance from two pole pieces is attracted more by one than by the other.

Bad insulation in one of the magnet coils may produce the same disturbance ; in this case, one of the brushes gives more sparks than the other (section 32), and we proceed in search of the defective bobbin, as shown in section 9.

The defect can easily be repaired when it is found to be on the exterior, but when it is inside the bobbins, the defective bobbin must be unwound, and rewound when the fault has been repaired.

(To be continued.)

MUNICIPAL ELECTRICAL WORKS.

We have been favoured with a memoir on this subject, reprinted from the *Elektrotechnische Zeitschrift*, on the occasion of the recent appearance of the annual reports of some of the more important electrical installations in Germany. These reports have emanated from the towns of Barmen, Elberfeld, Hamburg, Cologne, and Düsseldorf—places differing from each other in many conditions, and having works constructed on very various systems. In every case the new light has had to compete with existing gas works,

Under these circumstances it is satisfactory to find that the electric installations—all conducted on municipal account—show an average return of 3·5 per cent. on the capitals invested. These returns vary from 18·05 per cent. at Hamburg, to 6·62 per cent. at Cologne. The sums required for the sinking funds are from 1½ to 2 per cent. for the buildings, 4 to 5 per cent. for steam boilers, engines, and their belongings, 6 per cent. for accumulators, 3 per cent. for cables, and 8 to 10 per cent. on fittings. These figures throw a light on the probable average duration of the various departments.

Cologne is the only large installation on the alternating system, whilst the other five cities adhere to the continuous current system. The returns at Cologne are certainly lower in proportion than in the remaining cities. This fact cannot, however, be justly ascribed to the difference of the systems, since at Cologne the costs of the installation are higher in proportion to its working capacity than that in the other cities.

The Hamburg central uses relatively small sets of machinery, and it is consequently about to be remodelled by the firm, Schückert & Co., when it is expected that a considerable saving of fuel can be effected. The Hamburg works and those of Hanover, being situate in the middle of the respective cities, have to use smokeless fuel, *i.e.*, coke at Hamburg, and anthracite at Hanover. The Elberfeld works does not make use of accumulators. At Düsseldorf there are three sub-stations, with accumulators, in the middle of the city.

At Cologne, the salaries and wages are higher than those, *e.g.*, at Düsseldorf.

The tables appended to the reports show that the duration of the lamps installed comes up to the estimated figures in one instance only. This fact is of great importance for calculating the remunerative nature of an installation, and for fixing the price at which current can be supplied.

The demand for current for industrial uses and for tramways, &c., has latterly shown a satisfactory increase, especially at Berlin and Hanover.

REVIEWS.

Clarke's Tables, Memoranda, and Calculated Results for Plumbers, Architects, Sanitary Engineers, &c. Second Edition. London : R. Bush & Co., 92 and 93, Fleet Street.

In the preface the author states that the progress of events demands the addition of matter dealing with electrical work. Accordingly, he opens the new section with the rather extraordinary jumble :—"Nobody knows what electricity is. Its behaviour is, however, well understood, and the line between good and bad work is clearly marked." However, the remainder of the section contains much judiciously selected material, though, in the case of electric bells, the descriptive matter would be improved by a few diagrams explanatory of the connections of the same. The use of Fuller bichromates for electric bells, when the system is large, is suggested. We very much doubt if they would be found to give satisfaction, as they are certainly not suited for continued use, unless attention is frequently given to them. The general bulk of the press remains unaltered materially from that given in the first edition, though corrections have been made. The book is certainly a handy one, and is deserving of praise.

Helical Gears. By A Foreman Pattern Maker. London : Whittaker & Co., Paternoster Square.

The author of this work states, and rightly so, that the subject of helical gears is of growing importance, hence the publication of the book. The construction of the teeth of wheels is a favourite one for writers, but helical gearing has certainly not received the attention it deserves, and there can be but little doubt that there are many instances in which the designs of the same are very bad, and other cases where such gear could have been adopted with advantage, had proper confidence been felt in its correct running. The work is of a very practical character, and the general principles on which the gear should be designed are clearly ex-

pressed. Those who have had experience of toothed gearing know well the feeling of pleasure which the almost noiseless running of well-made teeth inspires, and the torture which the reverse gives; the latter is by no means uncommon, unfortunately.

The writer points out that when correctly hung, helical wheels will run more smoothly, with less friction, and less diagonal thrust than common spur or bevel gears, but it is vitally necessary that the design and construction of the rolling curves be precise, otherwise the result is a much worse form of gear than the common ones. The general contents of the book are as follows:—I. The friction of ordinary gears; II. The relation of the helix to helical gears; III. The case of straight teeth set diagonally; IV. Marking out and making spur tooth-blocks; V. Marking out and working bevel tooth-blocks; VI. Pattern gears; VII. Moulding helical spurs and bevels by machine; VIII. Splitting helical wheels; IX. Designing the forms of teeth; X. Practical results.

Theoretical Elements of Electro-Dynamic Machinery. By A. E. Kennelly, F.R.A.S. Vol. I.

This little volume of 87 pages is a collection of a series of articles published in the *Electrical Engineer*, of New York. It consists of six chapters; the first three deal with magnetic flux, magnetomotive force and potentials, and reluctance and permeance respectively. Chapter IV., with "the influence of iron in and on the magnetic circuit"; V., with "stress distribution," both in the magnetic medium and on conductors carrying current; while the last chapter is on electromagnetic energy. Although Mr. Kennelly states in the preface that his "desire and intention has been to develop for students of electrical engineering the applied or arithmetical theory of electro-magnetism, as distinguished from the purely mathematical theory," we confess that we cannot see the *raison d'être* of this work. It is pretty certain that if this book were put in the hands of a student who had not a fairly good previous acquaintance with the mathematical laws of electro-magnetism he would not benefit by it, and much in it would be unintelligible to him, while if he were thus equipped he would gain little by a study of it. Mr. Kennelly, in many cases, simply states formulæ without any attempt at reasoning them out, and then works an arithmetical example or two by substituting figures for symbols. This would, we fear, tend to encourage a fault that unfortunately seems to be inherent in many students, viz., to regard a formula as "something to conjure with," instead of a shorthand method of expressing a result that can be derived by purely logical reasoning from certain simple and fundamental laws. There are also given a number of diagrams of equipotential surfaces for various simple cases, where the quantities involved have particular numerical values, but no explanation is given as to how they are drawn, or how to obtain them if the numerical values were different. Throughout the book potential differences are expressed in ergs, and, on page 14, the author gives the following definition of potential:—"The magnetic potential at any point due to any magnetic body or system *is* the work which would have to be mechanically performed solely against magnetic forces in conveying a free unit north pole from an infinite distance up to that point . . . ." This is distinctly a misleading definition, as the word *is* should be replaced by *is measured by*, and we should have hardly expected Mr. Kennelly to fall into this error, although he later on contradicts it in a small footnote in which it is stated that potential when expressed in ergs, implies ergs expended on or by unit pole. The mistake of saying potential *is* work is a rather common one in elementary text books, but hardly so prevalent as that of expressing strength of magnetic field in *dynes*, an error into which almost all writers of small books on electricity and magnetism, unerringly fall. Mr. Kennelly apparently objects to the use of the term "induction" as flux per unit of area, and employs throughout the book the word "intensity"; this seems rather a pity, as the term "induction" is now so universally used in this sense, while "intensity" has been already requisitioned as "intensity of magnetisation," or magnetic moment per unit volume. In the commencement of Chapter IV., the increase in the magnetic flux, due to the introduction of iron, is clearly explained, the author pointing out that the effect of the iron may be regarded as either diminishing the magnetic reluctance, or as producing a magnetomotive force in the iron, coinciding with the exciting M.M.F. in direction, and that it is preferable to take the latter view on account of the fact that when the exciting M.M.F. is withdrawn, a residual flux remains.

In Chapter V., it is pointed out that when magnetic fields are mapped out by scattered iron filings, the density of distribution of the filings does not imply indication of the distribution of B, the magnetic induction, but of the product $B \cdot \frac{dB}{dx}$ where $\frac{dB}{dx}$ represents the rate of increase or decrease of the magnetic induction with respect to distance, and it is for this reason principally that when a broad flat polar face is plunged into iron filings, they congregate more thickly at the edges, as there the rate of change of induction is greater than near the centre.

Chapter VI. deals very shortly with the energy due to the magnetisation of the medium in the case of one or more circuits carrying current.

Electric Transformation of Power. By P. Atkinson. London: Crosby Lockwood & Son.

The title of this work is misleading, as there is nothing in the work relating to transforming of power. It is another book, like the dozens that are being sent out almost weekly from the press, dealing with ordinary motors and dynamos in a very ordinary method. The style is popular, and after the manner of the merchants' catalogues from which many of the illustrations are taken. It may be of use to non-technical readers who wish to comprehend in a general way what kind of machinery is used in electric power working; and it also gives an idea of the kind of motors and dynamos used in America for power purposes, but neither in the matter nor illustrations is there much either interesting or instructive for the student or electrical engineer.

How to Wire Buildings. By Augustus Noll. New York: C. C. Shelley.

It is extraordinary how little has been written on this very important subject. The extreme laxity on the part of supply companies in dealing with installations to which they supply current is, of course, intelligible; but that consulting engineers, and above all, architects, should be content to leave so much of the wiring of a building to fate is certainly difficult to understand.

The author treats portions of the subject very thoroughly, but always in such language as to appeal to the class of readers for whom he has written the book, namely, to men actually engaged in the work of installing. The book may, however, be consulted with advantage by foremen and others engaged in superintending wiring. It is, of course, impossible to cover the whole of the field open to discussion under the head of "How to Wire Buildings," and we think that perhaps the author might have done better in leaving out chapters dealing with elementary calculations connected with dynamo design, and in treating the very important electrical quantities, current, electromotive force, and resistance at greater length. So much misconception exists as to the real meaning of Ohm's law that the relation of these three quantities to each other cannot sufficiently be insisted on, especially when addressing working men.

Another matter to which we may take objection is the enunciation of rules, without any accompanying explanation as to how these rules have been arrived at. Thus in Chapter XXI. (dealing with the determination of the size of wire for a given percentage of loss when supplying a group of lamps) there would be no necessity for a "rule" at all had Ohm's law been thoroughly explained at the commencement, because such calculations involve nothing more than a transformed expression of Ohm's law. In the chapter dealing with energy and power the author, in arriving at the engine power required to produce a given electrical power, works with *efficiencies*. This is always puzzling to a working man as the added percentage is calculated on the total after addition, and not on the quantity to which it is added. It is more satisfactory to first explain the meaning of "counter

efficiency" and work with this quantity, as the calculations become much clearer.

There are one or two obvious oversights, as on page 146, where the author states that "two dynamos connected to the three-wire system are practically similar to two dynamos connected *in multiple*." This statement is practically corrected by one on the previous page to the effect that "with dynamos connected in multiple the pressure of all is equal to that of any one machine."

The book is illustrated by a number of diagrams indicative of systems of wiring and of methods of lighting large rooms, and some useful tables are given in the appendix.

First Principles of Electrical Engineering. By C. H. W. Biggs. London: Biggs & Co.

This is pre-eminently a book with an object, or, rather, to be strictly exact, two objects, the one of which is ostensible, the other, real. The ostensible object is stated by the author on the title page as "an attempt to provide an elementary book for those who are intending to enter the profession of electrical engineering." A very abortive attempt it is indeed, for there is no book we know of which is less fitted to be a help, or more fitted to be a genuine hindrance to those whom it professes to assist, than this of Mr. Biggs's. The real object of the book, however, is to act as a vehicle wherewith to air the author's fads and fancies. To anyone who has even an elementary knowledge of the subject, according to modern and generally accepted ideas, this is made abundantly evident from a perusal of it. But this is exactly where author and public join issues, regarding those generally accepted ideas. Mr. Biggs has somehow—mainly, we believe, from an inherent crookedness of vision—got the notion that those ideas are all wrong, and that he was born to correct them.

> The times are out of joint! O, cursed spite
> That ever *he* was born to set them right!

And so he, like a modern Don Quixote, erects sundry windmills (he doesn't call them "windmills," however, he calls them "existing notions"), and then gravely proceeds to demolish them. Will Mr. Biggs be surprised to learn that the greater part of what he preaches in this book as a new gospel has been generally accepted and taught for many years? It has not been taught, indeed, as set forth by Mr. Biggs—that would be a very great pity—but still it has been taught in such a way as to produce good, sound electrical engineers, who are capable in every respect of upholding the credit and advancing the cause of electrical engineering. As to the rest, which has not been generally accepted and taught, we give the author full credit for his originality of conception and for his lucidity of expression—with this one remark, that it had been better for Mr. Biggs's reputation, and much better for those who look up to him as a teacher, if it had never even been conceived, much less set forth in writing. Our whole views on this matter will be found succinctly stated by the author in that portion of the preface where he bombastically discounts anticipated criticism, "All in this book is to you new or old—*the new is untrue, the old is better said elsewhere.*" The italics are not the author's.

This second edition is described on the title page as "partly re-written and enlarged." The re-writing has helped to get rid of the worst of those eggregious blunders of statement, conception and calculation which disfigured the first edition. A large number, however, have been allowed to remain, and several entirely new ones have been perpetrated. The enlargement chiefly consists in the use of a larger and opener fount of type!

We much regret to see that, although the book professes to deal with the "first principles" of electrical engineering, no honest attempt whatever has been made in even the second edition to give a plain straightforward account of these principles, in such a way that beginners (for whom the book is specially written) can derive any benefit whatever from them.

As to definitions of the various terms employed, or even explanations of them, except in a very few cases, the author seems to ignore them completely. Beginners will, therefore, have to evolve these from their inner consciousness, or do without them altogether. It must have been either from want of will or want of knowledge that the author thus deliberately overlooks such important matters which only would have made his book intelligible to those whom it professes to assist. It certainly is not from want of space, for if he had confined his attention solely to the first principles of the subject and their elementary applications, he could quite well, within the limits of its 250 pages or so, have conveyed a great deal of solid and useful information. That he has not so confined himself even in his second edition, is evident from the fact that he has retained a great deal of what must be considered mere padding. He devotes seven pages to frictional and induction apparatus and to Leyden jars, about 13 pages to primary batteries (with *two* pages sandwiched in about secondary batteries), and begins his treatment of the dynamo with some 12 pages of elementary theoretical mechanics which he calls "Electro-Graphics." Further on he gives us a comparatively full and well written section on "Temperature of Coil," which, however, cannot be fairly considered as rightly belonging to a merely elementary work. That we are not wrong in designating all this as padding, we would call attention to the last chapter of the work where the author, after giving a four-page account of the tangent galvanometer, very ingenuously adds: "Such a galvanometer as that described, however, is not suitable for engineering work"! It is all the merest padding; for what does a budding electric light engineer want to know about Wimshurst machines, or the best way of joining up primary batteries? Or why dismiss alternators, transformers, and electro-motors with about four pages each, when these are subjects that he really wants information about?

We have neither the time nor the space to devote to a complete examination of the book, and to that thorough exposure of its numerous defects, which its demerits demand. One or two samples of its style of teaching must suffice. Faraday has laid it down, as the fundamental principle of electro-magnetic induction, that a difference of pressure is set up between the ends of a conductor which is in a magnetic field, so long as the conductor is cutting the lines of force of the field *at a constantly changing rate;* and that such difference of pressure is proportional, *cæteris paribus, to the rate of change in the number of lines so cut.* We have looked carefully all through the book for a clear enunciation of this most essential principle in any form whatsoever, but have failed to find one. On the other hand, we have found Mr. Biggs talking a great deal in his characteristically vague and loose way of the "looping" and "unlooping" of "loops of force" (these are part of Mr. Biggs's own phraseology) around a conductor, but always as if it were the mere *fact* (as distinct from the *act*) of looping and unlooping, which gave rise to the difference of pressure. We observe also that he still persists in saying that the maximum difference of pressure exists in an armature when the coils are moving *parallel* with the lines of force! In another place, the author shows a conductor forming an *open* circuit (which he calls a "conductive circuit"), brought into the field of a magnet; and declares that this will "set up a definite temporary *current* in the conductor." A *current* flowing in an *open* circuit! On the following page, moreover, Mr. Biggs says, in effect, that *all conductive circuits* must be *closed* circuits! Yet again, when speaking of the Foucault currents in an armature core, he refers to them within the space of half-a-dozen lines as "currents" and as "the current," as if he were speaking of the main current generated in the armature. In speaking of the magnetisation of iron, he makes use of the symbols, μ, B and H, but gives no adequate explanation at all of their meaning, how they are measured, or even what units are employed. But we are not surprised at this omission, for over and over again we observe that the author uses the term "strength of field" in such a way as to make it abundantly clear that he himself has no notion of its precise meaning. It is men like Mr. Biggs who put the adoption of a rational decimal system of notation into the far future. Because, forsooth, feet and inches pounds and ounces, pence and shillings happen to exist, that is reason enough for him why they ought to persist when all enlightened minds in the kingdom are crying out for their abolition. "In English workshops, and outside of pedagogic schoolrooms measurement is made in feet and inches, but the pedagogues throw every possible obstacle in the way of ordinary men knowing what they mean, for the sole purpose, it seems, of making people believe the subject is

difficult, when in reality it is exceedingly simple, and could, if put properly, be understood by almost every schoolboy in the sixth standard." All this is surely wrong-headed drivel. In intimate connection with the above, it is interesting to note that, on the opposite page, the author makes an arithmetical blunder which would ensure even a *second* standard boy a good caning. But perhaps it is only another printers' error, as also doubtless are the two following, which have been transferred, we note, from the former edition: At page 19, Mr. Biggs states that the coefficient (for copper) of increase of resistance with increase of temperature is "·002 *per cent.* per degree Fahrenheit." He then continues, "A piece of copper, therefore, having a resistance of 1 ohm at 32° Fah., would have a resistance of 1 + (·002 × 50), or 1·1 ohm at 82° Fah."! Then again, on page 133, he says, "The resistance increases about ·002—*that is about 2 per cent.*—for an increase of temperature of 1° Fah." Now, in the first place, "·002 *per cent.*" is wrong; in the second place, the succeeding arithmetical example is wrong; and in the third place, ·002 of any quantity is not 2 per cent. but ·2 per cent. of that quantity. In the name of all that is wonderful, how is a mere elementary student to reconcile the above statements, or detect which of them is right and which wrong? And yet, this is the book which the "gentle critic" is informed beforehand, "is intended to be an elementary one to the student of electrical engineering." Well, heaven help the student! for he will get precious small help here. We have jotted down two closely written sheets of errors in diagrams, examples, conceptions, statements, English, &c., but have no room to do more than merely mention the fact.

It is still to be regretted that Mr. Biggs in "partly rewriting and enlarging" his second edition, has not found room to give a complete description as well as a decent illustration of a modern dynamo, alternator, electromotor, transformer, or secondary battery, and that both arc and incandescence lamps are passed over with a mere allusion.

The treatment of the whole subject is very fragmentary and incomplete, and the arrangement of the various sections might be much improved. The language abounds in examples of faulty and slipshod composition, and even of bad grammar, which in many cases leave the meaning—such as it is—quite obscure. The index is about the only part of the book that is fully dealt with, and even it is not free from errors.

To sum up, we consider this book, as we before remarked, as a very dangerous one to be read by any man who is not armed at all points against its errors and misstatements. To those who are well up in the subject it ought to prove amusing reading, but to the beginner it would merely have the effect of unsettling his mind about all that he had previously acquired—it would rob him of his wheat, and give him nothing but chaff. At the end of the text, we observe the injunction "*respice finem*"—"consider the end." We have done so very carefully, and we consider that the proper end for all such mere chaff, will be found plainly set forth in the last clause of the 8th verse of the 6th chapter of Paul's epistle to the Hebrews. *Verb. sap. sat.*

THE PRACTICAL UNIT OF SELF-INDUCTION.

By ARTHUR WHITWELL, M.A.

Owing to the rapid development of alternate current systems of lighting and transmission of power during the last five or six years, self-induction has become of much greater importance than formerly, and has taken its place alongside of, and co-equal with, the familiar trinity of current, E.M.F., and resistance. In most of the older applications of electricity only steady currents were used, and self-induction did not enter into ordinary calculations, consequently, whilst most people had got clear ideas of current resistance and E.M.F., of the methods of measuring them, and of the units employed, they had very misty ideas of what self-induction was, and regarded it as something mysterious only written about in books, and not entering into the practical questions which concerned them. The alternator and alternate current transformer have altered all this, but even to-day we could find many electricians who have not sharp clear ideas as to what self-induction, an absolute unit of self-induction or a henry, really are. My object is to try and give briefly, and from first principles, a clear notion of what the henry or the practical unit of self-induction is.

In the C.G.S. system the units of length, mass, and time, are the centimetre, the gramme, and the second. The unit of force, called the dyne, is that force, which acting for one second on a mass of one gramme, will produce a velocity of 1 cm. per second. It is $\frac{1}{981}$ gramme. A magnetic pole acts on another pole with a force proportional to the products of the strengths of the two poles divided by the square of the distance between them, and a unit magnetic pole is defined to be that pole which acts on another exactly equal pole, at a distance of 1 cm., with the force of one dyne. Round about a magnetic pole, or electric current, there is a field of force which acts on a magnetic pole placed in it and urges it along a line of force with a force proportional to the product of the strength of the field, and the strength of the pole. A field of unit strength is one which urges a unit pole along a line of force with a force of one dyne. It is conventionally agreed that in a uniform field of unit strength there is one unit line of force in each square centimetre of area at right angles to the lines of force.

Suppose a closed circuit to be placed in a uniform magnetic field, and so moved that one unit line of force is added uniformly to the circuit every second, then an absolute unit of electromotive force is set up in that circuit. The E.M.F. in absolute units is thus the rate of adding unit lines of force to a circuit. A current is found to exert a force on a magnetic pole, proportional to the current to the length of the circuit, and to the inverse square of the distance of the pole, and an absolute unit of current is defined to be that current, one centimetre of length of which acts on a unit magnetic pole with the force of one dyne, every part of the current being distant 1 cm. from the pole. When an E.M.F of one absolute unit produces one absolute unit of current in a circuit, that circuit has one absolute unit of resistance. In an inductionless circuit, the relation between C E, and R is expressed by Ohm's law, and is always $E = C R$. In a circuit having self-induction a varying E.M.F. has to do two things: First, it has to overcome the ohmic resistance and drive the current, expending energy in the form of heat in so doing, and, secondly, it has to put a strain in the medium surrounding the circuit. This latter effect is equivalent to a back electromotive force, which is proportional to the rate of change of the current. The simple relation, $E = C R$, does not now hold. If the current is uniformly increasing, the new relation is

$$E = C R + L \frac{d C}{d t}$$

where L is called the self-induction of the circuit. Let us suppose the current to increase uniformly with the time and be $= t C$, then

$$E = t C R + L \frac{d (t C)}{d t}$$

or

$$E = t C R + L C.$$

The first term on the right is the part of the impressed E.M.F. which is driving the current; the second term is the back E.M.F., due to self-induction. If we suppose further that C is one absolute unit of current, that is to say that the current increases by one absolute unit per second, and also that the back E.M.F. of self-induction is one absolute unit of E.M.F., then the self-induction of the circuit will be one absolute unit of self-induction. We can thus define an absolute unit of self-induction as follows: a circuit has one absolute unit of self-induction, if, when the current is uniformly increasing at the rate of one absolute unit per second, the back E.M.F. is one absolute unit. The practical units of E.M.F., current, and resistance are 10^8, $\frac{1}{10}$, and 10^9 absolute units respectively. Now, supposing the current is increasing uniformly at the rate of one ampère per second, and the back E.M.F. is one volt, then the self-induction of the circuit is *one henry*.

From the relation, back E.M.F. $= L C$, it is evident that $10^8 = L \times \frac{1}{10}$, or that the henry is 10^9 absolute units.

The dimension of self-induction is simply *length*. We can get at this by considering our definitions.

Force between two magnetic poles $= \frac{m \times m}{d^2}$,

so that as the dimensions of force $= \mathrm{L\,M\,T^{-2}}$, the dimensions of magnetic pole are $\mathrm{L^{\frac{3}{2}}\,M^{\frac{1}{2}}\,T^{-1}}$. From the relation that the force on a pole = strength of field × strength of pole, we find that the dimensions of strength of field $= \mathrm{L^{-\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}}$.

The dimensions of E.M.F. are got from the relation:

$$\text{E.M.F.} = \frac{\text{Strength of field} \times \text{area}}{\text{time}},$$

and are $\mathrm{L^{\frac{3}{2}}\,M^{\frac{1}{2}}\,T^{-2}}$.

The dimensions of current are got from the relation: Force on magnetic pole

$$= \frac{\text{current} \times \text{length of circuit} \times \text{strength of pole}}{\text{square of distance of pole.}},$$

and are $\mathrm{L^{\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}}$.

The dimensions of resistance are got from the relation: $\mathrm{E = C\,R}$, and are simply $\mathrm{L\,T^{-1}}$, or velocity.

From the relation, $\mathrm{E = C\,R + L}\,\frac{d\,\mathrm{C}}{d\,t}$, it is evident that E and $\mathrm{L}\,\frac{d\,\mathrm{C}}{d\,t}$ have the same dimensions, and as $\frac{d\,\mathrm{C}}{d\,t}$ is of the nature of current ÷ time, L and t R have the same dimensions, that is the dimension of L is simply length. A henry is a second ohm, or 10^9 centimetres, or an earth quadrant.

ELECTRIC LIGHT ON SHIPBOARD.

Captain Froud, Secretary of the Shipmasters' Society, in a communication to the *Pall Mall Gazette*, corroborates our statements made last week on the subject of electric wires on shipboard. He shows a photo of some wires taken from ship circuits, one of which caused a fire. It was contained in—we cannot say protected by—a wood casing, in an engine room; bulk-head water got in freely.

It would be quite an easy matter to make rules for compelling the use of thoroughly protected wires. All wires should be armoured. Wood casing may then be used, if desired, for appearance sake; but it cannot be too strongly impressed on owners and builders that wood casing is no protection whatever, and ought never to be used.

Some rules regulating the wiring and fittings must be made, and we shall suggest some shortly.

The engine and dynamo are insignificant concerns compared with the wiring and fittings, and yet these, and a nice shiny switchboard, generally occupy the whole attention of the engineers who examine and accept ship installations.

It is something astonishing to find the high prices paid, for trashy little engines for ship lighting are sometimes just about three times the price for which they can be bought for other purposes. Yet a little extra outlay in wiring is at once objected to.

Captain Froud mentions that water found its way through a hole in a deck through which a wire passed. Such carelessness displayed in this case is most reprehensible; honest contractors make every hole in a bulkhead or deck perfectly watertight, but the jerry builder does not know even how such a thing is done. He also complains of the position usually chosen for the side lights on the electric lighted ships. That, however, is no fault of the contractor; the position of the lights is chosen for him.

CORRESPONDENCE.

A Pillar of Science.

In your article on "A Pillar of Science" you compare Siemens with the young men of the present generation, and use these words "That with young men of the present day the climbing of the ladder of fame has fallen into disrepute." Now, I maintain that is an unfair criticism, as it is only a part statement, and a part statement is generally a misstatement. Granted that some young men come under your heading, I presume you will admit that there are some who have attained to a degree of fame. It is to neither of these that I wish to draw your attention, but to those who have failed, and failed through no lack of trying, but through the obstacles that have been thrown in their way by those who should have given them a helping hand.

Now, sir, what are electrical societies and engineers doing for such as these? The general policy seems to be this: If a young man has several hundred pounds and can keep himself for about three years, he has a good opening into the profession, whether his natural abilities tend that way or not, but a young man who has natural abilities in this direction, and who might, in course of time, attain to a degree of fame, and be the means of opening up other paths of the science, has no chance, because he has not the above "monetary" recommendation. Again, I ask, what are officials of the society and prominent electricians doing, or going to do in this matter? Are they going to let the matter rest, and have the trade filled with mere mechanical machines, to the exclusion of better men? or are they going to take steps so that only those who are naturally fitted shall enter the profession?

H. D.

An Explanation.

Owing to the numerous inquiries we have had recently as to whether we have changed the constitution and address of our firm, we feel it incumbent on us to state there has been no change whatever, and that the partners, F. H. Nalder, H. Nalder, C. W. S. Crawley, and A. Soames, who have conducted the business during the last six years, still carry it on as Nalder Bros. & Co., and that our sole place of business is at 16, Red Lion Street, Clerkenwell, London, E.C., as heretofore.

Nalder Bros. & Co.

Crystal Palace Lighting.

In a recent number of your journal I saw a list of contracts carried out by a well-known firm, and among them:—"Crystal Palace: Complete lighting of the main nave, courts, &c., of the Crystal Palace with 90 arc lamps supplied with current from three Crompton dynamos, 500 volts, 30 ampères each, the lamps being 10 in series and 3 parallels. It is believed that this is the first time such an arrangement has been carried out, at any rate, on such an extended scale."

Will you allow me to state, in fairness to the permanent staff who fixed the Silvertown cables and executed all the work at the Palace, that Messrs. Crompton & Co. supplied the dynamos and lamps, &c., and that there is nothing very original about the scheme I prepared. The same thing was done, and on a much larger scale, at the Paris Exposition five years ago.

Wm. H. Massey.

Economical Age of Incandescent Lamps.

I notice in Lieut. Eyre's paper in your issue of the 2nd instant, that there seems to be an inaccuracy in the differentiation of $\frac{2\,\mathrm{L} + 2\,\mathrm{M}\,y}{2\,\mathrm{P}\,y - \mathrm{K}\,y^2}$, as the value of

$$\mathrm{Y\ is}\ \left(\sqrt{\frac{\mathrm{L}^2}{\mathrm{M}^2} - \frac{\mathrm{P\,L}}{\mathrm{P\,M}}} - \frac{\mathrm{L}}{\mathrm{M}}\right),$$

and not

$$\sqrt{\frac{2\,\mathrm{L}\,[\mathrm{P} - \mathrm{K}]}{\mathrm{K\,M}}}$$

I should be glad if you or any of your readers would explain this difference, and oblige.

H. G. Wood.

P.S.—There seems to be a printer's error, also, as P is said to be

$$\mathrm{P} = \frac{\mathrm{K}\,y}{x};$$

and what is meant is

$$\mathrm{Y} = \mathrm{P} - \frac{\mathrm{K}\,y}{x}.$$

BOOKS RECEIVED.

Thoughts on Faith and Scepticism. By Thomas Andrews, F.R.S. Published by James Nisbet & Co., 21, Berners Street, W. Price, 3s. 6d.

Lockwood's Builder's and Contractor's Price Book for 1894 By Francis T. W. Miller. Published by Crosby Lockwood & Son, London.

Electricity in the Service of Man. A popular and practical treatise on the applications of electricity in modern life. By R. Wormell, D.Sc., M.A. Revised and enlarged, by R. Mullineux Walmsley, D.Sc., &c. Published by Cassell & Co., Limited.

Modern Shafting and Gearing and the Economical Transmission of Power. By M. Powis Bale, A.M.I.C.E., M.I.M.E. Published by Wm. Rider & Son, Limited. Price 2s. 6d.

BUSINESS NOTICES, &c.

READY.—The Universal Electrical Directory (J. A. Berly's) for 1894. Orders for copies should be at once placed with Messrs. H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. The price of the book is 4s., post free.

Leicester Electric Lighting.—The engineer and manager to the Corporation Gas Department, Mr. Alfred Colson, M.Inst.C.E., has drawn up a report to the Town Council in connection with the tenders for electric lighting engines, in pursuance of a resolution passed by the Council at their last meeting on the 30th ult. The following is an abstract thereof:—On December 15th, 1893, ten firms were invited by the Gas Committee to submit tenders for the supply and erection at their central station, Aylestone Road Gas-works, of four horizontal compound condensing engines, three of which were to be of 300 B.H.P. each, and the fourth of 112 B.H.P. The specification under which the designs for these engines were to be prepared stipulated that "the governor must be capable of regulating the speed of the engine, so that without any adjustment by hand, whilst working, the speed at full load shall not be more than three per cent. less than with no load." While complying with the conditions of the specification, the competitors were to submit what they considered the best mechanical arrangement for the purpose. Of the ten firms invited, three declined to tender for reasons given. One tender was received too late for consideration. The tenders of the remaining six firms were opened by the Gas Committee on the 8th inst., and submitted by them to the Electric Lighting Sub-committee for their consideration and report. At a meeting of the sub-committee on the 10th inst., I presented an analysis of the tenders received. Previous to the meeting, I informed the chairman that after examining the drawings, specifications, and tenders in conjunction with the engineer of the Brush Electrical Engineering Company, there were in my judgment only two designs suitable for our purpose, viz., the design of Messrs. Musgrave & Sons, of Bolton, which provided engines for a total of 1,180 I.H.P., at the sum of £5,363, and an alternative design of Messrs. Hick, Hargreaves and Co., also of Bolton, for engines equal to 1,185 I.H.P., at the sum of £4,695. The tender of Messrs. Musgrave & Sons was exclusive of labourers required for the erection of the engines; the firm undertaking to supply skilled labour only, and that at a charge of 2s. 6d. per man per day extra to the amount of their tender. I strongly recommended the acceptance of the tender of Messrs. Hick, Hargreaves & Co. as being the lower of the two. In going through the analysis of the tenders with the sub-committee, the chairman was pleased to refer in favourable terms to the design submitted by Messrs. Jessop & Son, of Leicester. This design, though good in many respects, I have been compelled to reject with others. In an accompanying letter Messrs. Jessop & Son stated: "We have shown the engines with the dynamo placed between them, being the best way of distributing the strains, and the neatest arrangement. If, however, it is found necessary to apply the power at one end of the dynamo shaft, we can arrange our engines accordingly." As it was not clear to the sub-committee whether the alternative design was offered at the same price, the firm was communicated with by telephone, and upon their replying in the affirmative permission was given them to submit drawings of their proposed re-arrangement. It is this design and tender marked No. 9 in the analysis, as compared with that submitted by Messrs. Hick, Hargreaves & Co., and marked No. 7, that I have your instructions to report upon. In general arrangement the designs are similar, inasmuch as side by side engines, placed on one side of the dynamo, are provided for in each case. As to the large engines, they are equal as regards diameter of cylinders and length of stroke, but those offered by Messrs. Hick, Hargreaves and Co. are to indicate 350 H.P. each, at a cost of £3,945, while those offered by Messrs. Jessop & Son are to indicate 340 H.P. each, at a cost of £4,035. In the former case the engines would be supplied with Corliss valves and gear, and in the latter with Collmann's. Even without claiming any advantage for the additional indicated horse-power, this comparison shows a difference of £90 in favour of Messrs. Hick, Hargreaves & Co.'s tender, added to which the engines are supplied with a more costly and well-proved valve gear. The following are the particulars as regards the small engine offered by each firm:

Firm.	I.H.P.	Revolutions.	Size of cylinder.		Stroke.	Description of valve gear.	
			In.	In.	In.		
Hick, Hargreaves & Co.	135	118	11	20	24	Corliss.	£750
Jessop & Son	125	118	10	18	24	Hartnell.	£610

From this comparison of the small engines, there appears to be an advantage of £140 in favour of Messrs. Jessop & Son, but this amount would be more than equalled by the gain of the additional horse-power, and the extra value and superiority of the valve gear provided for in the engine offered by Messrs. Hick, Hargreaves & Co. I am thoroughly acquainted with the character of the work executed by each of the firms referred to, and after giving the most careful further consideration to this matter, I am bound to advise you (as I have already advised the Electric Lighting Sub-Committee, and also the Gas Committee) to accept the tender of Messrs. Hick, Hargreaves & Co., as by so doing you will be obtaining greater value for your money, and will be entrusting a difficult and responsible piece of work to one of the most experienced and competent firms of engineers in the kingdom. In conclusion, I may be permitted to point out that the Gas Committee, in adopting slow-speed direct-acting machinery in connection with their electric lighting station, are following Continental rather than English practice, and that the successful working of this system abroad has only been achieved by the use of engines of the most perfect design and workmanship. Correspondence and the analysis referred to are appended to the report. The Town Council considered this report at great length. In the end it was adopted by a majority of 21.

Davenport Arc Lamp.—A new small electric arc lamp is being placed upon the market, called the Davenport lamp, for optical lanterns. The lamps have been successfully used at the Society of Arts and the Camera Club. The inventor, Mr. G. Davenport, has sought in the improved lamp to provide one that can be used safely by persons unacquainted with electricity. This, it is claimed, has been attained by doing away with all mechanism usually employed in automatic-fed lamps and making the lamp a hand-fed one (central burning). The lamp consists of two carbon holders, so arranged that, while the lower carbon is automatically maintained in the proper position for burning by a spring within the lower carbon tube, the upper carbon is fed forward from time to time as the carbon is consumed, by a rod at the back of the lamp attached to a rack and pinion arrangement. It will burn about five minutes without attention or any sensible diminution of the light should the operator not be able to turn the rod. The tube containing the lower carbon is fastened by a thumbscrew to a fixed upright plate, having a slot cut in it so that the height of the tube may be varied and other adjustments made. The two carbons are set at an angle so that the full benefit of the arc is obtained directly in front. The lamp is made of such size and shape that it will fit any ordinary lantern without alteration, thus allowing of the limelight or other illuminant being used when the electric current is not available. The rod carrying the pinion for feeding the upper carbon projects at the back of the lantern, and the only attention necessary in using the lamp is to turn this rod from time to time in a similar manner to that required when turning the lime for the limelight. Special connections can be supplied for joining the lamp to the supply mains, which, while protecting the terminals from contact with each other, render it impossible to connect up the lamp in the wrong manner. The sole manufacturer and agent is Mr. J. H. Steward, of 406, Strand, W.C.

The Kingswood Electric Tramway. — The Bristol Tramways and Carriage Company, Limited, in their report just issued, publish the following paragraph:—"The directors have concluded their investigations with reference to electricity as a motive power, and they can now with confidence recommend the shareholders to approve of the adoption of the overhead system of electric traction on the existing line from Old Market Street to St George, as well as the proposed extension to Kingswood. The latter district is not only a very populous one but an important manufacturing centre, and has up to the present suffered from the want of means of communication with Bristol. The directors are prepared to recommend the shareholders to carry out this extension (the Parliamentary powers for which already exist), if the necessary authority is obtained for the use of electric traction; and, inasmuch as the population to be served by this line is approximately 60,000, the directors feel they may reasonably expect the hearty co-operation of the Local Boards, as well as that of the Bristol Corporation (in respect of the four streets within the city boundary), in order to secure the advantages of an electrical tramway for so important a portion of the community. To meet the capital outlays contemplated, it will be necessary to increase the capital of the company, and an extraordinary general meeting will be held at the conclusion of the ordinary business, for the purpose of creating 5,000 new shares of £10 each, to be issued upon such terms as the directors may, in the interests of the shareholders, deem expedient."

Electrically Lighted Piano.—On Monday last, at Anderton's Hotel, Messrs. A. Allison & Co. placed on view for inspection by press representatives, a new bell metal bridged pianoforte which is lighted by electricity. Incandescent lamps of 3 C.P. take the place usually occupied by candles. The current is obtained from a set of batteries situated in the centre of the desk above the keyboard of the instrument. The electrical apparatus is, of course, entirely distinct and separate from the internal working parts of the piano, so that no accident can arise from the batteries being upset inside. This new application of electric lighting was devised by Mr. Allan Frazer. It is a capital improvement, but in the matter of price it will not bear comparison with the old method of candle lighting.

Electric Lighting at Liverpool.—Messrs. Bennett and Druce, 44, Fishergate, Preston, have lately completed an installation of electric light at Messrs. Glazebrook & Rigby's, of Liverpool, including the whole of the extensive cellars owned by the firm. They have also wired the new offices of the Liverpool Grain Storage and Transit Company, Limited, and Messrs. Clunie & Co., of the same town, for connection with the Liverpool Supply Company's mains.

Price Lists, &c.—Messrs. Cox-Walkers have sent us a copy of their pamphlet describing electric telltales, electric fire alarms, lightning conductors, signals, electric indicators, and bells.

From Messrs. Lea, Sons & Co., of Shrewsbury, we have received a copy of their sheet No. 13, descriptive of their electrical swing joint.

Messrs. Dick Kerr & Co., Limited, have published a new catalogue of gas engines and pumps. There are some first-class illustrations, some of the blocks, however, look as though they have been scamped in the printing. Good paper has been used, and the general get-up has been carefully attended to. Gas engines of single-acting, vertical, horizontal, double-acting horizontal engine fitted with patent electric lighting governor, special tandem engine for electric lighting and other purposes, these and other machinery, including complete generator gas plants, are allotted necessary space. At the end of the catalogue is a photographic view of the north end of their gas engine erecting shop.

Messrs. Nalder Bros. & Co. have sent us a copy of their last catalogue containing a large amount of information regarding, and prices of, electrical testing, mathematical, optical, and other scientific instruments manufactured by them. The book is excellently printed, as is usual with the firms' publications, and crowded with numbers of first-class illustrations.

Lea, Sons & Co.—This firm has recently designed and patented an improved electrical swing joint. With this joint there is always a clear wire-way at whatever angle the fitting may be turned, and abrasion, or breakages of the conducting wires is impossible.

The working parts being very small, the joint can be introduced in the form of an astragal or ornament, adding greatly to the appearance of the fitting. It is the only joint that can be used for a curved bracket, and the makers claim to have produced the cheapest swing fitting in the market.

Electric Light at Swansea.—The South Wales daily papers last week contained an exceedingly lengthy description of some new premises lately opened by Mr. John S. Brown, engineer and ironmonger, in Oxford Street, Swansea. The premises, from the illustrations given, have the appearance of a palatial edifice. An extensive electric light installation has been indulged in. The shop door and windows are lighted by means of eight Waterhouse arc lamps of 2,000 C.P. each. In the basement, offices, galleries, and showrooms are 113 incandescent lamps of various C.Ps. In addition to these, two lamps of 6,000 C.P. are fitted, one underneath the glass roof, and the other in the tower over the front entrance. On the tower in the rear of the building is to be erected, sooner or later, a search light projector. The electric light plant, which is situated in an engine room in the basement of the building, consists of a Stockport gas engine, driving an Elwell-Parker compound wound dynamo, fitted with fly-wheel and extra bearing, and designed for an output of 10,000 volts.

State of Trade during the Year 1893.—Messrs. Cox-Walkers have been very busy during the year 1893, which has, in point of turnover, been larger than any previous one. Among other considerable contracts, they succeeded in obtaining that for the supply and erection of tell-tales, telephones, and fire alarms at the London County Council's new asylum at Claybury, Essex. They have also carried out several large installations of electric light in various parts of the country, and this portion of their business is rapidly extending. Their work also for the last year has included telephones and signalling apparatus for the Edinburgh and District Water Trust; the Royal Edinburgh Asylum, and colliery work of various kinds.

Monmouth and Electric Lighting.—The Local Government Board have declined to grant borrowing powers for electric lighting until the Corporation have obtained their provisional order. The Board also question the practicability of using the water from the River Wye as a motive power. Messrs. Bramwell & Harris have accordingly been engaged to examine and report regarding the turbines. If their report is favourable the Local Government Board will be again approached.

Mildé Telephones and Electric Supply Company, Limited.—We are informed that the business hitherto carried on at 60, Watling Street, London, E.C., under the style of "Ch. Mildé & Co.," has been turned into a limited company under the above title. A prospectus with share application form can be had on applying to the company. Further details will be found in our "City Notes." A new catalogue is in course of preparation and will be out shortly.

The New Telephone Company, Limited.—The third annual gathering of the staff took place at Manchester, on Friday evening last, the 2nd inst. There were upwards of 80 ladies and gentlemen present, including a considerable number of friends. The evening was a most enjoyable one, the songs and recitations given by various members of the staff and friends being much appreciated.

Gas Engines.—We understand the patent duplex high-speed electric light gas engine will be on show running next week in the showrooms of the sole agents, the Indestructible Gas Ignition Tube Company, Limited, 100c, Queen Victoria Street, E.C.

Huddersfield Electric Lighting.—The Huddersfield *Chronicle* says that on Tuesday evening, last week, one of the electric lights near the George Hotel went out, and was followed shortly by an explosion in the base of the stand on which the lamp pillar is erected. There was a loud report, and the small door at the base of the stand was blown away a distance of three yards. Flames issued from the base and continued to burn until the arrival of one of the workmen from the electric lighting station, who switched off the current from the lamp.

"Durol."—A new hardening composition for steel, called by this name, is being placed upon the market by Messrs. William Holz & Co., of 78, Bishopsgate Street Within, E.C. It is stated to have been tested and approved by the largest ironworks, steel manufacturers, mechanical engineers, &c., on the continent, and excellent results have been obtained. It is claimed that steel manufactured with "Durol" obtains the hardness of a diamond whilst retaining its tenacity and temper.

Theatre Lighting.—The Grimsby "Prince of Wales" Theatre has been lighted by electricity. There are 300 lights of 16 and 25 C.P. in the building, including foot lights and orchestra jets. The exterior is illuminated by two arc lamps of 1,000 C.P. each. A dynamo, fixed by Messrs. King & Co., of Hull, is driven by a 14-H.P. Tangye gas engine.

Great North of Scotland Railway.—A new department has been instituted by this company in connection with the electrical lighting of the joint station, the Palace Hotel, Guild Street, Aberdeen, as well as the telegraph system of the company. It will be known as the "Electrical Department," and will be under the charge of Mr. Fossette, from the electrical department of the General Post Office of London.

Electric Light at the London School Board Offices.—The plant for this installation, which is in the basement of the new buildings, consists of two Babcock-Wilcox water tube boilers, which supply steam to a pair of Parsons steam turbines and dynamos of the radial flow type, each capable of supplying 32,000 watts. There are upwards of 1,000 lights.

Electric Lighting at Dover.—The Town Council on Tuesday had before them an estimate for installing the electric light into the Maison Dieu and Connaught Halls by the Brush Company. The estimated cost of wiring and fitting for the Maison Dieu Hall was £330, and for the Connaught Hall, £572 12s. It was decided to accept the tender for the fitting of the Connaught Hall only.

Bolton Electric Lighting.—The Gas and Electricity Committee of the Bolton Corporation have ordered tenders to be obtained for the construction of the four transformer sub-stations which will be placed at the junctions of the principal streets in the compulsory area.

Walthamstow and Electric Lighting.—Mr. Geo. Francom asked the Local Board to allow him to erect overhead wires and supply electricity to other premises as well as his own. That body have now refused to sanction the application.

Edinburgh Electric Lighting.—The Electric Lighting Committee have opened the tenders for the proposed electric lighting station which is to be situated in Forphichen Street. Between 30 and 40 estimates were received.

Conversazione.—The *employés* of Messrs. Anderson and Munro, electrical engineers, Bothwell Street, Glasgow, held their annual conversazione in the Clarendon Hall, St. George's Cross, on Friday, the 26th ult.

Electric Light at Turkish Baths.—The Southampton Turkish Baths, erected by the corporation at a cost of about £1,100, and opened on Monday, are fitted throughout with the electric light.

Aberdeen Libraries and Electric Lighting.—Mr. Murray, inspector of electric lighting, has been instructed to report as to the electric lighting of the whole of the library premises by electricity.

Ballamena and Electric Lighting.—Tenders are to be invited shortly for lighting the town from August 16th to May 16th, either by gas or electricity.

Coventry and the Electric Light.—Messrs. G. & I. Steane, architects, have been instructed to prepare plans and specifications for a central station, with a view to obtaining tenders for the same.

Harrow Electric Lighting.—A Local Government Board enquiry is to be held regarding the application of the Local Board to borrow money for the purposes of electric lighting.

Church Lighting.—The church and rectory of St. Peter's, Lancaster, is to be illuminated with electric light.

Birmingham and Electric Lighting.—It is proposed to light the market Hall by electricity at a cost of £1,000.

Bridge Electric Lighting.—The Glasgow new service bridge is to be lighted by electricity.

Stafford and Electric Lighting.—Tenders for central station buildings and plant are to be advertised for.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—February 20th. For supplying and fitting up electric wiring and fittings for the Northern Co-operative Company's central premises. Copy of specification, schedule, and litho plans may be had from Mr. John Ferries, secretary, 54, Loch Street, Aberdeen, on receipt of 10s., which will not be returned.

Dewsbury.—The guardians invite tenders for lighting the workhouse and premises by electricity. Plans and specifications may be seen, and forms of tender obtained upon application at the office of Joseph Peace, Union Office, Wellington Street, Dewsbury.

CLOSED.

Belfast.—The Corporation has accepted the following tenders for the supply and erection of electric lighting plant. Prof. Kennedy was the adviser:—Messrs. Dick, Kerr & Co., for tandem and single engines, with Siemens Bros.' dynamos; Messrs. J. H. Holmes & Co., Limited, for switchboards; the Electrical Power Storage Company, for batteries; Messrs. Scott & Seller, for road work; Messrs. R. Maclaren & Co., for cast-iron work; Messrs. Doulton & Co., for insulators; Callender's Bitumen Company, for vulcanised bitumen; the British Insulated Wire Company, for lead; Messrs. Curtis & Sons, for copper strip; amounting in all to £12,984.

Sunderland Electric Light Scheme.—Tenders for the erection of the buildings required at the electric light station have been opened. There were eight tenders for the buildings which were estimated to cost £3,014 11s. 11d. The lowest tender received was for £3,167, and this was accepted. The highest tender was £4,053. For the chimney shaft there were also eight tenders, but their consideration was adjourned. For the supply of iron roofing there were six tenders, the amounts being pretty close. The tender of Messrs. J. Abbott & Co., Gateshead, for £235 was accepted.

LEGAL.

Edison-Bell Phonograph Corporation, Limited, *v.* Smith and Another.

The hearing of this action, which is in respect of Mr. Edison's patent No. 19,953 for phonographs, was resumed before Mr. Justice Wright, sitting in the Queen's Bench Division of the High Court on Saturday.

Sir R. Webster, Q.C., Mr. H. F. Moulton, Q.C., Mr. Bremner, and Mr. J. C. Graham were the counsel appearing for the plaintiffs; Mr. R. B. Finlay, Q.C., Mr. Bousfield, Q.C., and Mr. Lewis Edmunds were on the other side.

Sir R. Webster replied on behalf of the plaintiffs.

Mr. Bousfield having also addressed the Court, Mr. Justice Wright said he would take time to prepare his judgment.

Sir R. Webster hoped his lordship would give them an indication of the conclusion he had come to at the earliest moment, as it was important in view of the manner in which the machines were being dealt with.

Mr. Justice Wright saw no objection to his stating the result of the judgment he had arrived at. He would give his reasons afterwards. He was quite prepared to give judgment for the plaintiffs; he would give the full reasons on Wednesday.

Mr. Justice Wright did not think there were any special circumstances to entitle him to give costs on the higher scale.

Mr. Bousfield asked for a stay of execution pending an appeal.

Mr. Justice Wright said he would not stay the injunction, but he would stay the enquiry as to the costs and damages.

At the Law Courts, yesterday, Mr. Justice Wright delivered his judgment in this case. His Lordship explained that the action was brought in respect of the infringement of Mr. Edison's patent of November, 1889, for improvements in the phonograph. The defendants did not deny that the plaintiffs' specification disclosed some new and useful inventions, nor did they deny the infringement. But they relied upon objections to some of the claims appended to the specification as invalidating the patent. The phonograph in its rudimentary stage, in about 1877, consisted of a small circular diaphragm sensitive to the vibrations of sound, on the centre of which was fixed a small rod or style. The point of the style was so arranged that at each vibration of the diaphragm it slightly indented a sheet of tinfoil rolled round the cylinder, and so a record of the vibrations was produced. To reproduce the vibrations the point of the style was made to traverse the indentations over again under a proper pressure, and in so doing it retransmitted to the diaphragm vibrations more or less similar, and the diaphragm returned those vibrations to the air. In the period between the invention of the phonograph in that primitive form, and the date of the plaintiff's patent in 1889, some important improvements had been made. One was that in place of the tinfoil there had been substituted a cylinder coated with a waxy or resinous substance. That involved the use of two separate styles, one for recording and the other for reproducing, because a cutting point was necessary for recording and a blunt point for reproduction. That necessitated the disadvantage of having two separate diaphragms, each carrying a point, and those had to be adjusted by the operator. Another great improvement was the introduction of the floating weight, which automatically applied the proper pressure; but it still remained for the operator to adjust the machine. That was an outline of the state of advancement the instrument had reached before the date of the invention disclosed in the plaintiffs' patent. The effect might be summed up in one sentence. The parts were too numerous, and the minutest accuracy of adjustment was essential. That had to be maintained by a skilful manipulation of different parts frequently applied. In 1889 Mr. Edison reduced the number of separate parts, and produced automatically and rapidly, with mechanical certainty, effects which previous depended on personal adjustment and nicety of manipulation. It was found the floating weight was sufficient to regulate also the recording point, and that made it possible to return to the system of one diaphragm. The single diaphragm carried the two points. That was the substance of the invention which the plaintiffs had patented, although they sought to protect other improvements and details. The specification stated that the object of the invention was to simplify the construction of the phonograph, by decreasing the parts of the machine, and avoid the necessity for adjustment whilst the machine was in operation. The first claim was for the placing of two points on the same diaphragm, means being provided whereby either of the points might be brought into operative position on the surface of the phonograph. That claim was said to be too general, too wide, and to lack novelty. Other of the claims were attacked for want of invention and utility, and there was the usual conflict of expert evidence on the point. Mr. Edison himself was examined on commission, and even had his evidence stood alone he (the learned Judge) should have seen reason for thinking that each of the details contributed something important, and possessed some degree of novelty, and that each was the result of long study and experiment by a person of the greatest mechanical skill. All were attached to the very machines the defendants sold. Before the inventions, interruptions had been frequent in working the old machines. Since their adoption all difficulties had disappeared, and the operator need no longer be an expert. As to the details, all of them, except, perhaps, two, appeared to be claimed only in combination with the principal invention, and if that were new and properly described the patent was not invalidated. If the public could not use the particular invention, A, at all without E, it did them no harm to say they must not use A plus E together. At present, however, it could not be contended that the use of one diaphragm carrying two points, so that either could be brought to bear, was not novel. The invention protected by patent was that which the specification disclosed. A specific claim was not essential at all, nor even under the last Act. Old inventions, although described, were not claimed; on the other hand, the real invention was claimed. In this case, the first claim seemed to him sufficient to support the judgment he had given for both purposes.

Mr. Lewis Edmunds said the patent related only to certain detailed improvements in the machines, and it was quite possible to remove those improvements and yet leave the instruments, or parts of them, of considerable value to the defendants. He apprehended the plaintiffs would only be entitled to the delivery up of the infringing parts.

Mr. Justice Wright said he never heard any such contention. He had given his judgment on Saturday, and was *functus officio*.

The Gold Trust and Investment Company, Limited, *v.* the Electric Tramcar, Limited.

In the High Court of Justice, Chancery Division, before Mr. Justice North, this case was heard. It was a motion in a debenture holder's action to commit Alfred James Jarman, of 71, St. John's Hill, Clapham Junction, and Watson Smith, of 63 and 64, New Broad Street, to prison for contempt of Court in interfering with the receiver of the Court by having taken away from a certain shed accumulators and other property of the defendant company. It appeared that Jarman was a person who had been employed by the receiver and had a key of the shed. Watson Smith was manager of a company called the Elieson Accumulator Syndicate. He had contracted to buy from the receiver certain tramcars, accumulators, and plant, for £250, and patent rights for £10, to be paid on delivery. He purported to sell the same chattels to the Elieson Accumulator Syndicate for £2,000, partly to be paid for in debentures. That company immediately contracted to sell the same property to a trustee for a new company for £15,000. The accumulators and some other goods were removed by Watson Smith, with the aid of Jarman, without paying anything, or leave from the receiver.

Mr. George F. Hart appeared for the plaintiffs in support of the motion.

Mr. J. W. Clark, for Jarman, pleaded that the conduct of his client was *bonâ fide*, though mistaken.

Mr. Watson Smith appeared in person.

Mr. Justice North made an order for the committal of both Jarman and Watson Smith. In the course of his judgment he observed on the difference of amount between the prices named in the three contracts. He could not say whether the price in one case was too high, or in another too low. That he had nothing to do with. Commenting on the evidence, he said he could not see anything *bonâ fide* in the conduct of the respondents; on the contrary, he might give it a very different name. As an order for committal was pressed for, he must make it.

Hammond *v.* The Brighton and Hove Electric Light Company, Limited.

This was a debenture holders' action, which came before Mr. Justice North on Saturday, at Brighton.

Mr. Eve, who appeared for the plaintiff, stated that debentures were issued to the amount of £15,000, each of the value of £100, bearing interest at the rate of six per cent. The principal monies were repayable on January 1st, 1895, or earlier if default was made in payment of the interest. The company had made default in payment of the half year's interest, due in January last, and a receiver and manager had been appointed.

Mr. Chitty appeared for the company.

His Lordship declared that the holders of the debentures were entitled to a charge upon the property and undertaking of the company, and directed the usual inquiries, with liberty to apply, as to a sale.

NOTES.

Good "Morning."—Again Dr. Herbert Tibbits has lost the day. It is with pleasure that we have to congratulate the defendants in one more of his actions on a victory gained. The *Morning* is the latest paper that has been let in for the expense and trouble of a libel action, but as was fully anticipated, the poor Doctor has again, though he made out a very pitiful story, had judgment given against him. It is about time he forsook the fields of litigation, and expended his labours and time upon less troublesome and more remunerative proceedings than those of the Law Courts, for, so far as libel actions are concerned, the fates are arrayed against him.

Portsmouth Electric Lighting.—Some delay has occurred in the completion of the electric light installation at Portsmouth owing to a difference which has arisen between the engineering department and the committee having charge of the work. The proposed charge for the hire of the meters has, by resolution of the committee, been reduced from £1 to a sliding scale, viz.:—Ten lights, 2s. 6d.; 20 lights, 3s. 6d.; 40 lights, 4s. 6d.; 60 lights, 5s. 6d.; and 100 lights, 7s. 6d.

Proposed Extension of the French Pacific Cable.—According to the *Sydney Morning Herald*, Mr. Audley Coote has written to the Government of New South Wales with reference to a proposed extension of the French Pacific cable. Mr. Coote lately left Australia for England to further a scheme for extending the present French cable from New Caledonia on to Samoa. Mr. Kidd, Postmaster-General of N.S. Wales, states that no promises have been made to Mr. Coote with reference to this extension. Mr. Kidd has, he states, considered Mr. Sandford Fleming's proposals, and also the objections made concerning them by Mr. Coote. He, however, does not think it advisable to make Mr. Coote's letter public, which goes very much into detail, and is more a departmental than a public document. From expert information which Mr. Kidd has obtained concerning Mr. Sandford Fleming's proposals, he thinks that objection may be taken to the lengths of some of the sections, and it is to be feared that it would be difficult to maintain an electric current of sufficient power. The whole matter will, however, be gone into at the forthcoming inter-Colonial Postal Conference.

Polyphased Currents in 1893.—It is interesting to note what installations worked by diphased or triphased alternating currents, which only came into existence three years ago, are now in use throughout the world. Up to the present old Europe distances young America in the new departure opened up for electrical industry, as may be seen from the following list:—*France.*—Three installations of triphased currents: (1) Saint Victor-sur-Loir, at Saint Etienne, 3 units of 200 kilowatts, one of which is in use; (2) Pont-Lignon, 1 unit of 200 kilowatts; (3) Florensac (Hérault), 1 unit of 200 kilowatts. These three installations work on the Lauffen-Heilbronn system, and were established by Messrs. Guitton and Bertolus, of St. Etienne. *Germany.*—Four installations, also worked by triphased currents, Lauffen-Heilbronn, Bockenheim-Frankfort, Erding & Wangen, in Allgan (Wurtemberg). *Austria.*—Two installations, Pergine, triphased currents, and Buda-Pesth, diphased currents. *America.*—One alternating current installation only, established scarcely two months ago by the General Electric Company at Redlands, in California. As a temporary experimental installation on a large scale, we must mention that of the Westinghouse Company, at the Chicago Exhibition, which comprised 12 diphased alternators of the Tesla system, of 750 kilowatts each. These 12 large diphased alternators, which are now no longer working, will no doubt be turned to account for the distribution of electrical energy in certain American towns, and we shall certainly hear of them again shortly. Lastly, if we consider the number of installations contemplated, or in course of execution, not forgetting the gigantic project for the utilisation of the Falls of Niagara by means of diphased alternating currents, and by units of 5,000 H.P., we can form some idea of the future in store for polyphased currents.

Lithium by Electrolysis.—*L'Industrie Electrique* gives an account of a method, due to Mr. Guntz, for obtaining metallic lithium by electrolysis from the fused electrodes. He finds that the amount obtained is greatest as the temperature diminishes. A mixture containing chlorides of potassium and sodium gives better results than those produced by pure salts; this he attributes to the lower fusing point. Pure chloride of lithium melts at 600° C., but a mixture of equal weights of chloride of lithium and potassic chloride melts at 450° C. This is said to be the best proportion to use. The "Digest," N.Y. *Electrical World*, has a note on these experiments.

"Trading Companies and their Creditors."—Our financial contemporary, the *Economist*, in its last week's issue, has an article upon this subject. We have previously referred to the importance of the question upon the electrical industry, and are glad to note that the disabilities of trade creditors are being brought to light generally. We take the following extracts from our contemporary's article, and endorse the recommendation of registration, the necessity of which was, in fact, alluded to by us when drawing attention to the subject some time ago.

That there should be no limit to the borrowing powers of limited liability companies is one of the most singular anomalies of our joint-stock law; yet it is only within the last year or two that any degree of attention has been devoted to this evil. Mr. Edward Manson, of the Middle Temple, a recognised authority on company law, has just published a substantial volume on "The Debentures and Debenture Stock of Trading and Other Companies." The book is a workmanlike digest of the law relating to debentures, but makes no pretence of dealing with desirable or necessary reforms. Mr. Manson points out that though a company cannot borrow "unless a power to borrow is expressly given, or is incidental to the company's objects," in practice it results that as borrowing is incidental to a trading company's business, the power to raise loans is virtually unlimited. . . . . What cannot but strike the student of this branch of company law is the freedom given by the Legislature to trading companies, as compared with the restrictions placed on railways and other joint-stock concerns of a semi-public character. A promoter may make the capital of a company anything he pleases, and give it unlimited borrowing powers. When a company does borrow, mortgaging every fraction of its tangible assets and even its prospective income, it need not keep any public register of the charges existing. A register of mortgages must certainly be kept at the company's office, but access to this is only given to creditors or shareholders, so that no one proposing to enter into business relations with the company has an opportunity of ascertaining whether or not there is any margin of uncharged assets to secure him if he become a creditor. But a railway company is compelled to deposit a register of its loans every half-year at Somerset House, and this though railway accounts containing all these particulars are made up in a statutory form, and are readily accessible to the public. What is a necessary precaution in the case of responsible undertakings, such as our railways generally are, under the close supervision of the Board of Trade, is surely more necessary in the case of trading companies, which are required to make merely perfunctory returns each year. When Parliament finds time to seriously consider the amendment of the Companies Acts, it can hardly ignore this point. Mr. Manson points out that "a person proposing to lend money to a trading company must satisfy himself that, in the first place, it has borrowing powers, and, in the next, that it has not exhausted them." The first question can be answered by study of the articles of association at Somerset House; the second can only be decided by examination of the mortgage register at the company's own office, to which an intending creditor has no legal right of access. The want of a public register of mortgages and charges may thus become as serious for a debenture-holder as for a trade creditor, though it is chiefly in the interests of the latter that we advocate the more public disclosure of the position of trading companies as regards borrowed capital. . . . . It is remarkable that the first serious official recognition of the disabilities suffered by trade creditors of limited companies should have occurred during the proceedings of a committee on winding-up. Mr. Justice Vaughan Williams's trenchant evidence appears to have made a strong impression on the Departmental Committee, and it is to be hoped the impression will go deeper, and affect the future course of legislation. Mr. Manson's book shows that, save as regards the absence of legal restriction on borrowing powers, and the want of accessible information as to the extent to which these have been exercised, the position of debenture-holders is very secure, and needs little strengthening. It is the trade creditor who needs protection. . . . . It is virtually impossible to decide when there is and when there is not an uncharged margin of assets in a trading company, where the debentures have a floating security over a fluctuating property. We fear, therefore, that Mr. Justice Vaughan Williams's first proposal must be dismissed as impracticable. But with the right of access to a register of loans and charges, an intending creditor may always arrive at an approximate idea whether or not a margin of unappropriated assets exists, and were Parliament to give him this privilege, and the winding-up procedure in debenture actions to be altered as Mr. Justice Vaughan Williams desires, the position of Trade creditors of limited companies would be considerably improved, without injury to debenture-holders, who are well provided with means to take care of themselves.

Appointments.—Mr. J. Stewart has been appointed engineer and manager of the Derby electric light works, with Mr. A. E. P. Moore as assistant engineer.

City and Guilds of London Institute.—The Executive Committee of the City and Guilds of London Institute have changed the name of the Guilds Central Institution, in Exhibition Road, to the Guilds Central Technical College.

Liverpool Trades Council and Electric Lighting.—At a meeting the other day, the Liverpool Trades Council passed a resolution in favour of the City Council adopting a system of electric lighting for Liverpool, the electricity to be generated by tidal force.

Accident on Birmingham Tramways.—One of the electric cars was going along Suffolk Street, Birmingham, last Friday, when the machinery attached to the front portion of the car slipped off, and the front bogie coming in contact with it was broken, while the car itself ran completely off the line. To get the vehicle any further was impossible, and it was, therefore, rendered necessary to move the car from the lines in order to maintain the traffic.

Electric Light at Glasgow.—The Corporation Galleries of Art have been lighted by electricity, under the supervision of Mr. Arnot. On January 30th the light was used for the first time, and proved a thorough success. There are 50 Crompton arc lamps distributed throughout the various rooms, incandescent lamps being used in the corridors and staircase; 12 lamps are in the main gallery, and eight in each of the side halls, the remainder being fitted in the public apartments on the upper floor.

Lectures.—A special course of evening lectures on electro-deposition has been arranged for at the City and Guilds Technical College, Finsbury. During the course Prof. Silvanus P. Thompson, F.R.S., will deliver three lectures, as follows:—(1) "Explanation of Methods of Measuring Currents, Electromotive Force, Resistance, Conduction and Insulation in their Application to Electro-Deposition." (2) "Current Generators, Explanation of the Ways in which Dynamos, Batteries, and Accumulators give a Current, and on the proper sorts of dynamo machines for electro-deposition." (3) "Electrolysis: its law and Nomenclature." The complete course consists of 12 evenings, commencing Wednesday, February 14th. The fee for the course is 10s.

At the monthly meeting of the Leeds Association of Engineers, Mr. W. D. Warsbrough, of Lincoln, read a paper on "The History and Development of the Portable Engine."

Before the Oxford Junior Scientific Club last Friday, Mr. F. A. Hillard read a paper on "Carborundium and other Substances prepared by means of the Electric Arc."

A lecture on "Electricity and Some of Its Modern Applications" was delivered last week by Mr. James Bell, A.I.E.E., in Russell Schoolroom, Dundee, under the auspices of the Russell Literary Society.

Chicago Awards.—There has been an unprecedented delay in announcing the awards made at the Chicago Exhibition. No list of awards has yet been issued, and it seems quite uncertain when one will be. Many awards have been announced, but none have as yet been officially confirmed. Sir Henry Wood has, however, at different times, received information, from which it appears that about 1,400 awards have been made in the British Section. Of these 836 were in the industrial departments of the Exhibition, and were divided among 449 exhibitors. The total number of industrial exhibitors was 597. Of 501 exhibitors in the Fine Arts Department, 132 received an award; of 1,138 exhibitors in the Women's Work Section, 173 received among them 229 medals; 180 awards went to Indian manufacturers represented at Chicago either independently or in the Indian Pavilion; 54 awards went for British exhibits (like Mrs. Ernest Hart's Donegal village) not under the jurisdiction of the Royal Commission. The lists from which the above statements are collected, it is understood, is liable to modification, so the figures must only be regarded as approximative. In Paris, in 1889, 926 awards were distributed among 1,017 exhibitors.

Bolton School Lighting.—Leigh Technical School and Free Library are to be lighted by electricity.

Society of Arts.—On Wednesday next, February 14th, at 8 p.m., a paper on "The St. Pancras Electric Light Installation" will be read by Prof. Henry Robinson, M.Inst.C.E. Mr. W. H. Preece, C.B., F.R.S., will preside.

Testimonial.—The students of the Durham College of Science, Newcastle, have decided to make a presentation to Principal Garnett, who leaves the college in June. The special form which the testimonial is to take has not yet been decided upon. Subscriptions will be received up till April 21st.

Liverpool Quack Committed for Trial.—Whilst the crusade against electrical quackery has suffered an apparent check in London, it has met with success at Liverpool, where last week Francis M. Colville, *alias* Prof. Hamilton, was committed for trial, charged with obtaining £52 12s. from John Gardner, a labourer, by pretending that he was a medical man, and selling him medicine and a so-called electrical belt. Evidence was given that the belt was of no value whatever, and that the prisoner had no knowledge of either medicine or surgery. The prisoner was admitted to bail in two sums of £500 each.

Monopolies in France.—The Paris correspondent of the *Times* states that the St. Etienne and Montluçon municipal authorities were three years ago ordered by the Council of State to compensate the gas companies for allowing the introduction of the electric light. On Friday last the same tribunal gave judgment in favour of a claim for the assessment of damages by the gas company of Argentan against the municipality. The latter had not only allowed an electric light company to lay down wires, but had allowed it the use of a site for its works. The judgment contains a recital that, whenever a gas company has been accorded a monopoly for any fixed period, compensating advantages have always been guaranteed to the local authorities in the shape of cheap rates or participation in profits

"Pall Mall Gazette" and Harness.—The *Pall Mall Gazette* of Tuesday last contained the following paragraph:—"So many inquiries have been addressed to us as to the recent prosecution of Mr. C. B. Harness, at the instigation of Colonel Brasyer and others, that we feel it only right to state that that prosecution was not suggested, promoted, instigated, countenanced, or directly or indirectly aided or abetted by us, nor did we know that such action was contemplated till application was made for a warrant. The charges we made against Mr. Harness are to be tried in the civil action which we presume and sincerely hope he still intends to proceed with against us. From the moment of the service of the writ upon our solicitors we abandoned all attempts to secure a public investigation into the truth and justice of the charges we made against the late manager of the Medical Battery Company, Limited, other than that which a trial of the civil action could best supply." We have every reason to believe that the wish of our contemporary will not be gratified.

The Fatality at Prescot.—In our last issue we briefly referred to the accident at Prescot, which caused the death of a lad named Henry Waide, 14, whom it now transpires was employed by the British Insulated Wire Company, who light Prescot with electricity. On the previous day to that on which the accident occurred, the boy was engaged with an electrician named Jones in a cellar of the premises in Eccleston Street. Jones left him for a few minutes, and on his return found him lying on the floor. The lad's finger and thumb were burnt, showing that he must have pulled the wire. Jones said that Waide was a careful lad and knew the danger. The wire was insulated, but was fresh put up two days ago. The joint was broken by some means where he touched. A hole the size of the point of a nail would be sufficient to let the current through. It was one of 2,000 volts. They were about to fix a wooden guard over the transformers, and the boy was there to watch it. The wire had evidently been grasped, as it was pulled from its position. The boy had no right to touch the wire He had been at the work for five months

Blackpool Extensions.—£24,000 is to be spent on electric lighting plant, and £45,000 on the gas works.

Old "Oils" at the Academy.—Before the French Academy, M. Levat has recently described a means for clarifying olive oils, of inferior quality, by electricity.

Maidstone and Electric Lighting.—Five tenders were received for the proposed electric lighting installation. Nothing definite has yet been settled in regard to them.

Correction.—In Mr. Tanner's article on the Goebel-Munchhausen Lamp story in our last issue, a printer's error occurred in p. 113, line 47, *i.e.*, for "Court divisions," read "Court *decisions*," and line 57, for "another division," read "another *decision*."

Disturbing Currents.—The Austrian Government Telegraph Department have published regulations which are to be observed in the construction of electric railways, with a view to avoiding the effects of disturbing currents upon telegraph and other lines. These are given in *Zeit. fuer Elek.*, December 15th, 1893.

Birkenhead and Electric Lighting.—Mr. James N. Shoolbred, C.E., of London, is to be engaged to advise the Corporation as to the details of the system of electric lighting to be introduced. A sub-committee have considered with Mr. Shoolbred the question of a suitable site upon which to erect the generating station.

Great Eastern Railway and Electric Lighting.—At this company's meeting last week the chairman, in the course of his speech, stated that they had decided to light Liverpool Street station, the Liverpool Street hotel, the Bishopsgate Low Level station and Goods station, and Bethnal Green Junction with the electric light, served and distributed by the Great Eastern Railway themselves. They had incurred an expense already under this head of £35,000. They believed that the expenditure would not only be of advantage to the public, but of service to the company itself.

Fire-damp Detector.—*La Lumière Electrique* mentions the apparatus devised by Hardy for the detection of fire-damp. It is based on the principle that two organ-pipes, tuned to the same note, will "beat" when one is operated by pure air, and the other by air mixed with gases; a telephone transmits these beats to any desired locality. We do not know what Prof. Clowes would say of such a system; but it would seems to us that the ninety-nine other influences which tend to put organ-pipes out of tune would seriously affect the amount of dependence which could be placed upon this device.

Studies on the Potential of Metals.—Researches on the difference of potential between pairs of metals have been very numerous, but there is evidently plenty more to be done. This field of investigation has always appeared to be a promising one, and there is yet something more to be harvested from it than crops of mere numerical data. In a recent number of the *Zeitschrift*, W. D. Bancroft describes his experiments with magnesium, zinc, cadmium, tin, lead, bismuth, mercury, and platinum in various salt solutions. He finds that when the first six of these are paired up, neither the positive nor the negative ion of the solution has any effect upon the E.M.F. The latter also remains constant, even when the dilution varies from 10 to 1,000. On the other hand, when mercury forms one pole of the pair, the influence of the negative ion is very marked, but concentration does not affect the E.M.F. Concentration, at least when the solution is that of a haloid salt, determines the amount of the difference of potential when platinum forms one of the pair; in such cases, the platinum does not appear to act as an ion. The conclusion is arrived at that the E.M.F. of the combination $M_1 \mid R\,X \mid M_2$ is identical with that of the reversible combination, $M_1 \mid M_1\,X \mid M_2\,X \mid M_2$; but it must be admitted that the agreement of the numerical data is rather approximate than absolute.

Accident to Telephone Linesman.—A man named William Dolan was engaged in rearranging the telephone wires at a shop in the Walworth Road on Tuesday, when he lost his balance and fell from the top of the building. He was taken to the hospital, but death ensued shortly after arrival.

NEW COMPANIES REGISTERED.

Fowler, Lancaster & Company, Limited (40,344).—This company was registered on the 23rd ult., with a capital of £50,000 in £10 shares, to carry on the business of electrical engineers, contractors and manufacturers, to equip, maintain, work, use and let on hire, electric light and power plant, telegraph and telephone instruments and appliances, cables, wires, or other apparatus and works connected with electricity and magnetism, and to light streets, houses, and other places, by electricity. The subscribers (with one share each) are:—T. G. M'Lauchlan, Handsworth, physician; C. H. T. Bikker, 67, Temple Row, Birmingham, wine merchant; E. W. Lancaster, Bristol Road, Edgbaston, engineer; G. E. Stembridge, Birmingham, manager; C. O. P. Pemberton, 69, Temple Row, Birmingham, agent; G. M. Fowler, Longbridge, Warwick, engineer; W. Hands, 2, Edward Road, Edgbaston, accountant. The number of directors is not to be less than two nor more than five. Qualification, 50 shares; remuneration to be fixed in general meeting. Registered by Haxham and Rawlinson, solicitors, 42, Bedford Row, W.C.

Easton, Anderson & Goolden, Limited (40,371).—This company was registered on the 26th ult. with a capital, of £200,000 in £10 shares, to acquire and take over as a going concern, by way of reconstruction, the undertaking of Easton & Anderson, Limited (incorporated 1888), the assets and liabilities, and to carry on the business of civil, mechanical, and general engineers. The subscribers (with one share each) are:—T. P. Wilson, 7, Brechin Place, S.W., civil engineer; F. S. Courtney, 76, Redcliffe Square, S.W., civil engineer; J. E. Compton-Bracebridge, 3, Whitehall Place, S.W., civil engineer; E. W. Anderson, Roydon Lodge, Erith, civil engineer; W. T. Goolden, 28, Westbourne Gardens, W., electrical engineer; L. B. Atkinson, 22, Albany Road, W., civil engineer; J. R. Easton, 3, Montpelier Road, W., civil engineer. The first directors are T. P. Wilson, J. E. Compton-Bracebridge, E. W. Anderson, F. S. Courtney, W. T. Goolden, and L. B. Atkinson. Qualification, £5,000; remuneration, £250 per annum each. Registered by Hollams Sons, Coward & Hawkesley, Mincing Lane, E.C.

Mildé Telephones and Electric Supply Company, Limited (40,384).—This company was registered on the 29th ult. with a capital of £20,000 in £1 shares, to carry on the business of a telephone, telegraph, and electric light, heat, and power supply company, and in particular to establish and work exchanges and works for the supply of electric light. The subscribers (with one share each) are:—V. W. Jones, 24, Queen Victoria Street, E.C., gentleman; Q. A. McConnell, 60, Watling Street, E.C., engineer; W. Milford, Aberystwith, South Wales, mining engineer; E. Duchamps, 5, Rue Langier, Paris, engineer; E. F. Hodge, 32, Old Jewry, E.C., solicitor; L. D. Tottenham, 32, Old Jewry, E.C., solicitor; W. Saurin, 60, Watling Street, E.C., accountant. There are never to be more than seven directors; qualification, £100; remuneration £50 per annum each, and percentage. Registered by Farmer, Gray & Tottenham, 32, Old Jewry, E.C.

Mosley and Company, Limited (40,422).—This company was registered on the 1st inst. with a capital of £11,000 in £1 shares, to purchase patents, &c., for depositing zinc by electricity, or otherwise upon steel, iron, or any other metal; and to work and develop these patents in every way. The subscribers (with one share each) are: Wm. Thorpe, 35, Altofts Terrace, Beeston Hill, Leeds, clerk; Thomas Hainsworth, 32, Aberdeen Walk, Armley, Leeds, clerk; T. Coombs, 26, Bond Street, Leeds, accountant; W. H. Stocks, New Street, Earlsheaton, clerk; J. Day, 15, Athlone Grove, Armley, Leeds, clerk; T. Naylor, 18, Crab Lane, Armley, Leeds, clerk; H. B. Farr, 11, Moorville Place, Beeston Hill, Leeds, clerk. Almost the whole of Table A is applicable. Registered by Waterlow & Sons, Limited, 85—88, London Wall, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electro-Magnetic Medical Plaster Company, Limited.—This company's statutory return shows that out of a nominal capital of £10,000 in £1 shares, 2,540 shares have been taken up, with 10s. called on each of 540. A sum of £245 has been received; £2,000 has been agreed to be considered as paid, and £25 is still outstanding.

British Volta Electric Glow Lamp Company, Limited.—This company's statutory return shows that out of a nominal capital of £2,000 in £1 shares, 542 shares have been taken up, with 6s. called on each of 142 shares. A sum of £36 13s. has been paid in response to calls; £400 has been agreed to be considered as paid; and £5 19s. is in arrear.

District Messenger Company of Paris, Limited.—The statutory return of this company shows that out of a nominal capital of £200,000 in 112,000 £1 preference, 80,000 £1 ordinary, and 400 £20 founders' shares; 67,875 preference, 30,082 ordinary, and the whole of the founders' shares have been taken up. There has been 15s. called on each of 47,875 preference and 10,082 ordinary shares; £1,841 5s. has been received, £48,000 has been agreed to be considered as paid, and £41,626 10s. is outstanding.

Electric Construction Company, Limited.—The statutory return of this company shows that out of a nominal capital of £400,000 in 150,000 ordinary, and 50,000 seven per cent. cumulative preference shares, all of £2 each, 120,000 ordinary and 12,845 preference shares have been taken up, with the full amount called on each. A sum of £265,690 has been agreed to be considered as paid.

Coventry Electric Tramways Company, Limited.—The statutory return of this company shows that out of a nominal capital of £25,000 in £5 shares, seven shares have been taken up and fully paid.

Bourne and Grant Electricity Supply Company, Limited.—The statutory return of this company shows that out of a nominal capital of £25,000 in £1 shares, 18,207 ordinary and 100 founders' shares have been taken up, and that 10s. has been called on each. There has been a sum of £9,078 10s. received, and £75 is outstanding.

Electric Anti-Corrosion Company, Limited.—Messrs. Ince, Colt & Ince, have informed the Registrar of Joint Stock Companies that this company is not now carrying on, and never has carried on, business.

"Electrical Plant," Limited.—The annual return of this company shows that out of a nominal capital of £10,000, in £10 shares, 575 shares have been taken up, with 500 issued as fully paid. The full amount has been called and paid on the remaining 75 shares.

Lilly & Lilly, Limited.—The statutory return of this company shows that out of a nominal capital of £10,000, in £20 shares, 225 shares have been taken up, with the full sum called on each. An amount of £2,960 has been received, and £1,540 has been agreed to be considered as paid.

London and Lancashire Electric and General Engineering Company, Limited.—The statutory return of this company shows that out of a nominal capital of £20,000, in £5 shares, 1,786 shares have been taken up, with £2 called on each of 786 shares. A sum of £1,146 has been received, £5,000 has been agreed to be considered as paid, and £426 is outstanding.

Ander's Telephone Company, Limited.—The registered office of this company is now at 5, Great Tower Street, E.C.

Cycle and Electro-Plating Company (Saville's), Limited.—The registered office of this company is now at 52, Corporation Road, Middlesborough, Yorks.

Dover Electricity Supply Company, Limited.—This company's registered office is situated at 49, Queen Victoria Street, E.C.

Canterbury Electricity Supply Company, Limited.—This company's registered office is at 49, Queen Victoria Street, E.C.

Mazarron Electric Light Company, Limited.—The registered office of this company is situated at 175, Dashwood House, E.C.

James Macintyre & Co., Limited.—The statutory return of this company shows that out of a nominal capital of £50,000, in £10 shares, 1,755 shares have been taken up, with 10s. called on 601 shares, £8 on each of 250, and £4 on 250. The total sum received is £9,010, and £6,540 has been agreed to be considered as paid.

CITY NOTES.

The Wilson Tariff Bill passed the House of Representatives last week, and there seems little doubt that Mr. Wilson's scheme, after sundry emendations and manglings, will become law. It has yet to pass through the two Houses of Congress, and the process may involve considerable lopping off of clauses, so that the final form may dash the hopes of English manufacturers. However, the Bill in its most modified form will clear away the worst features of the M'Kinley tariff, though to what extent foreign goods will be affected it is difficult to say. The original form adopted by the Committee of Ways and Means has already been altered out of all recognition, and many of the articles which were to be admitted free have had fresh duties imposed. The free import of coal and iron ore has remained untouched, and possibly machinery may get through with small duties. At the same time every clause in the Wilson Bill will be most vigorously opposed, for it must be understood that the passing of the McKinley Bill brought into existence manufactures which could not have survived without the artificial shelter provided by the McKinley tariff; therefore a revision of duties means the over-riding of vested interests, and the outcry may be strong enough to prevent moderate imposts becoming law.

We have been much interested in a correspondence in the *Pall Mall Gazette* on the value of an audit. Judging from some of the letters, it would appear that it is not every auditor who understands his position with regard to the shareholders. We are afraid this arises from a misconception of the law. Primarily, an auditor is a shareholder's representative, called in to check the directors' accounts, and if he fails to do this properly, he is shirking the work for which he is paid. A correspondent, signing himself "F. G. K.," speaks sensibly on the question. He rightly says: "That it is an auditor's duty, as an independent servant appointed by the shareholders, to act towards them as honestly as any other employé, and he should not hesitate in suggesting reforms in the keeping of the accounts, and should not go automatically to work by accepting every transaction presented to him as regular, and wherever necessary, in the eyes of a critical man, he should probe it to the beginning." We are afraid that the auditor too often considers he is called in to assist the directors in preparing their accounts for a shareholders' meeting. He is, unconsciously it may be, falling away from his legal responsibilities, and neglecting his duties to the shareholders, and naturally there is growing up a certain distrust of the value of an audit, and unless auditors as a body adopt some drastic measures, they are bound to fall still lower in the estimation of the public. It is perfectly clear that if auditors had had a perception of their duties, many colossal frauds would have been prevented. At the same time it is only fair to point out that shareholders obviously neglect an important duty when electing or re-electing auditors. Too often the election is a mere matter of form, and very often the chairman or director will, illegally, propose the election. Shareholders, to protect their property, should exercise due caution when accepting a firm of auditors, who, by the way, are generally suggested by the directorate.

The annual report of the Newcastle and District Electric Lighting Company is to hand, and shows a most satisfactory increase in the output, 388,422 units of electrical energy having been supplied, as against 290,469 units supplied in 1892. We propose to deal fully with the accounts next week.

The accounts of the Kensington and Knightsbridge Company are exceedingly satisfactory. Since the issue of the last report the transference of the St. Mary Abbot's district from the Chelsea Company has been ratified, and when this new area has been thoroughly exploited the company should show first rate earnings. There is an increase in lamps, due, to some extent, to the addition of St. Mary Abbot's district, but there has been considerable extensions in the original area—11,826 lamps have been added, which brings the total connected to 64,529. Three and a-quarter miles of additional mains have been laid down, but the increase of lamps more than keeps pace with the additional mains, and the fairly good lamp density per yard

of main is still maintained. We quite share the directors sanguine expectations of the St. Mary's district, and the fact that 5,262 lamps are already connected argues well for the future.

After paying the dividends on the 6 per cent. first preference shares to June 30th, 1893, on the 5 per cent. second preference shares to September 30th, 1893, and an interim dividend at the rate of 4 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1893 is £4,788; of the above sum, £1,456, has been appropriated for the payment of the first preference dividend to the end of the year, and £88 has to be set aside to meet the portion of the dividend on the second preference shares to the same date, leaving £3,244, out of which it is proposed to pay a further dividend on the ordinary shares at the rate of 6 per cent. on the past half-year, making a total dividend for the year of 5 per cent. This leaves a balance of £1,059.

The receipts for the sale of current amount to £20,746 7s., against £16,628 for 1892. We find, on making comparisons, that the receipts have increased just about as much as the St. James's Company have decreased, the increase in the Kensington being £4,118, the decrease in the St. James's receipts being £4,174. It may be said that these are worthless comparisons, inasmuch as the St. James's Company have, through competition, been compelled to reduce their rates. It is impossible to say how far this affects the St. James's revenue, but it ought to be pointed out that the average price per unit obtained by the Kensington Company is considerably less than last year, it being 6·8d. against 7·44. Then, again, the heavy legal charges of the St. James's Company are, to some extent, reflected in the Kensington Company's accounts, for the two companies were practically co-defendants in Dr. John Hopkinson's three-wire case. We hope to have something to say about the working costs next week; but, so far as we can at present judge, the additional output has been obtained with only a moderate increase of expenditure:—

	1893.	1892.	1891.
Total capital invested	£174,260	£154,400	£125,000
Number of units sold	724,308	535,343	385,050
Number of lamps connected ...	64,529	47,441	38,408
Revenue from sale of current ...	20,746	16,628	12,266
Average price obtained per unit ...	6·8d.	7·44d.	7·66d.

Cost.	£	s.	d.	Per unit. d.
Coals and other fuel, oil, waste, water and engine room stores, wages, and sundries ...	4,147	3	11	1·37
Salaries	1,489	15	6	·49
Repairs and maintenance, buildings, engines and boilers, dynamos, motors and other machinery	83	0	5	·02
Rent, rates and taxes	821	19	8	·26
Management expenses, directors' remuneration, salaries of managing engineer, auditors, law and parliamentary charges, insurance, &c. (Preliminary expenses, bad debts, £450 16s. 7d.)	1,990	17	0	·66
Renewal account, buildings, mains, plant, batteries, and meters	4,059	3	6	1·34
Sinking fund	103	0	0	·02
Total	£12,695	0	0	4·2d.

We do not think that the shareholders of the India-Rubber and Gutta-Percha Company have much cause for complaint in the report of last year's working. It is not quite as good as that for the previous year, but the generous dividends of 12½ per cent. are still maintained, and £50,000 goes to swell the already magnificent reserve fund. The net profit is £94,607 4s. 2d. Considering that trade last year was said on all hands to be bad, the company is to be congratulated on the results. Adding £46,844 17s. 5d. carried forward from last year, and deducting £25,000 interim dividend paid in July, there remains a disposable balance of £116,450. Of this £50,000 goes to reserve, and after paying dividend and bonus equal to 12½ per cent., £28,952 is carried forward.

A comparison of the past three years may be interesting.

	1893.	1892.	1891.
	£	£	£
Net profit	94,607	99,161	79,102
Added to reserve fund ...	50,000	75,000	25,000
Carried forward	28,952	46,844	42,073

A financial contemporary thinks that the large sum owing to the the company ought to be explained. No doubt the sum is considerable (£122,000), but taking into account commercial depression, particularly in the electrical industry, it is not surprising. Apart from the brighter outlook which now prevails, we expect that the debts are fairly secure.

Mildé Telephones and Electric Supply Company, Limited.

For the purpose of acquiring the business and British rights of Messrs. Ch. Mildé, Fils & Co., of Paris, this company has been formed. The company intend establishing local, provincial, and private telephone exchanges for hotel services, central railways, ships, mines, factories, &c., and maintaining the same; also to carry on other branches of electrical works, such as electric light signals, &c.; further, to supply telephonic accessories and electric light apparatus. All the British and Colonial customers on the books of the firm in Paris will be transferred to the new company. The vendor receives, as sole consideration for all the rights, royalties, and contracts to be acquired by the company, £5,000 in fully paid up deferred shares, ranking for dividend only after 7 per cent. is paid on the preference shares. Mons. Ch. Mildé, managing director of the Paris firm, will act as a director, and Mr. M. Kotyra has been retained as managing director. The other directors are Q. A. McConnell, C.E., W. Milford, and V. W. Jones. Wm. Saurin is the secretary, and the general offices are situated at 60, Watling Street, Queen Victoria Street, E.C. The present capital is £20,000, in 15,000 cumulative preference shares of £1 each, and 5,000 deferred shares. Applications are invited for the preference shares.

Sunbeam Electric Light, Limited.

The annual meeting of this company took place on 31st ult. at the offices, Park Road, Gateshead. The company was formed in 1887 for the manufacture of incandescent electric lamps, and articles produced by the company were first publicly used at the Jubilee Exhibition in Newcastle. Until that time the capacity of these lamps was about 100 candle-power, but at the Exhibition they ranged from 300 to 1,000. Lamps are now made by the company up to and exceeding 2,000 candle-power. Those who attended the meeting yesterday were given an opportunity of inspecting the works at the old and historic Gateshead Hall, and a review of the process of making the lamps, from stage to stage, was an interesting study. The report of the directors was an encouraging one, and showed that the company are briskly employed executing orders. Captain Chapman, J.P. (of Messrs. Clarke, Chapman & Co., Limited), was re-elected a director. Mr. Edmundson was reappointed managing director, and Messrs. Thomas Bowden & Son were reappointed auditors. Mr. T. J. Grainger is secretary to the company.

The City of London Electric Lighting Company, Limited.—Subject to the completion of the audit, and after making the necessary provision for repairs, maintenance, renewals, and reserve funds, the directors, out of the profits for the year ended December 31st, 1893, will recommend the payment of the full dividend at the rate of 6 per cent. per annum on both issues of the preference shares of the company, payable on and after the 23rd inst., carrying forward a substantial balance to next account.

Newcastle-upon-Tyne Electric Supply Company, Limited.—The sixth general meeting of the above company was held on 31st ult. at the Station Hotel, Newcastle. The directors' report and balance-sheet having been adopted, a dividend at the rate of 4 per cent. per annum for the half-year ending December 31st last was declared, which, together with the interim dividend paid in July last, makes 4 per cent. for the year.

Telegraph Construction and Maintenance Company, Limited.—The directors recommend a dividend of 15 per cent. (£1 16s. per share), in addition to the 5 per cent. already paid, making 20 per cent. for the year 1893.

Westminster Electric Supply Corporation.—A dividend at the rate of 5 per cent. per annum for the half-year has been declared.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 4th, 1894, amounted to £951; week ending February 5th, 1893, £956; decrease, £5; total receipts for half-year, 1894, £4,790; corresponding period, 1893, £4,910; decrease, £120.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of January were £3,900; as compared with £3,976 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of January, 1894, amounted to £1,909, against £1,901 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in January 1894, were £21,000; corresponding months, 1893, £20,800; corresponding month, 1892, £20,000.

The Hobart Electric Tramway Company. The receipts for December, 1893, amounted to £1,488; January, 1894, £1,682.

The Western and Brasilian Telegraph Company, Limited. The receipts for the week ending February 2nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £3,207.

SHARE LIST OF ELECTRICAL COMPANIES

Present Issue.	Name.	Stock or Share.‡	Closing Quotation January 31st.	Closing Quotation, February 7th.	Business done during week ended February 7th, 1894. Highest.	Lowest
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	42 — 44 xd	42 — 44 xd	...	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	78½ - 79½ xd	79½ - 80½ xd	80	79
2,932,680£	Do. do. Deferred	Stock	7¼ - 7⅜	7⅛ — 7⅜	7 7/16	...
130,000	Brazilian Submarine Telegraph, Limited	10	11⅛ — 11⅜	11⅛ — 12	11⅛	11 1/16
18,700£	Do. do. 5 p. c. Bonds	100	99 —102 xd	99 —102 xd	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝ — 2⅞	2⅝ — 2⅞	2⅞	2⅝
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2⅛	...
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	104 —106	104 —106	106	105½
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4⅛ — 5	4½ — 5	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½ — 11⅝	11 — 11⅛	11½	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	13 — 13½	12⅞ — 13½	13¼	13 1/16
10,000,000$	Commercial Cable, Capital Stock	$100	130 —140	135—145	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16 — 3/16	1/16 — 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	3 — 4	3 — 4	3½	3 1/16
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12⅛	11⅛ — 12⅛	...	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	9½ — 10	10 — 10½	10	9⅝
400 000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞ — 15⅛	14⅞ — 15⅛	15⅛	14⅞
70,000	Do. 6 p. c. Preference	10	15⅝ — 16⅛	15⅝ — 16⅛	16⅛	15⅝
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	106 —109 xd	107½	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 —117	114 —117	116⅝	115⅝
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅛ — 15⅜	15⅛ — 15⅜	15⅝	15 1/16
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	101 —104	101 —104	...	...
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104	101 —104	103⅜	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	113 —116 xd	113 —116 xd	...	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	102½	102½
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	102 —105 xd	...	...
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	106 —109 %	106 —109 %	...	...
120,000	Electric Construction, Limited, Nos. 1 to 120,000	£2	½ — 1	¼ — ⅝	⅝	½
12,845	Do. do. 7 p. c. Cum. Pref., Nos. 1 to 12,845	2	1 — 1⅛	1⅛ — 1⅜	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	... ...	1/16 — 3/16	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/16 — 5/16	3/16 — 5/16	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/16 — 3/16	1/16 — 3/16	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	¼ — 1⅛	¼ — 1⅛	...	...
180,227	Globe Telegraph and Trust, Limited	10	8⅜ — 8⅝	8⅜ — 8⅝	8⅝	8 1/16
180,042	Do. do. 6 p. c. Preference	10	15⅛ — 15⅜	15⅛ — 15⅜	15 7/16	15 5/16
150,000	Great Northern Tel. Company of Copenhagen	10	20¼ — 20⅝	2 ¼ — 21⅜	21½	20⅝
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	23 — 24	23 — 24	24	23½
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 44	41 — 44	43	42
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4⅜ — 4½	4⅜ — 4½	4⅜	4⅜
15,000	Do. do. fully paid	5	6½ — 6⅝	6⅛ — 6⅜	6¼	...
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	4⅛ — 5⅛	5 — 5¼	5 1/32	5
6,295	Do. do. Pref., £6 paid	10	8⅛ — 8½	8⅛ — 8½	...	...
37,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	105 —108	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£10 paid)	10	8⅛ — 8⅜	8 — 8⅛	8 5/16	8¼
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —108	104 —108	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	⅛ — 1⅛	⅛ — 1⅛	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	2 — 3	2 — 3	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝ — 4⅞	4⅝ — 5	4 15/16	4⅝
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½ — 15½	14½ — 15½	15	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14 — 15	14 — 15	14⅝	14 7/16
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ — 5⅜	5¼ — 5½	5 7/16	5 5/16
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 — 114	112 —114	113¾	113
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4½ — 5½	4½ — 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼ — ⅜	¼ — ⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	101 —104	101 —104	...	...
11,802	Reuter's Limited	8	5½ — 6½	5½ — 6½	...	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	5½ — 6 xd	5⅝ — 6¼xd	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅜ — 8¼ xd	7⅜ — 8¼xd	...	...
3,381	Submarine Cables Trust	Cert.	114 —119	113 —118	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2¼ — 2⅜	2 — 2¼	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	36 — 38	42 — 44	42⅞	37
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	... ...	... ...	...	...
58,000	United River Plate Telephone, Limited	5	1½ — 2	1½ — 2	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	3 — 5	3 — 5	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	...	...
30,000	West Coast of America Telegraph, Limited	10	2 — 2½	2 — 2½	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —101	97 —101	...	...
64,242	Western and Brazilian Telegraph, Limited	15	5⅞ — 6¼	6¼ — 7	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5¼ — 5⅝	5½ — 6	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1¼ — 1⅝	1⅝ — 2¼	2	1⅝
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	102 —105 xd	...	...
222,700£	Do. 5 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	102 —105 xd	104½	103½
88,321	West India and Panama Telegraph, Limited	10	1 — 1½	1 — 1½	1 1/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½ — 10	9½ — 10	9⅝	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	105 —108	107¼	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 —118	113 —118	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	102 —105	102 —105	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5¼ — 5⅜	5⅛ — 6	5⅜	...

‡ Unless otherwise stated all shares are fully paid.

† Quotations on Liverpool Stock Exchange.

Subject to Founders' Shares.

* 100

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5⅜—5½.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 106—108.—Electric Construction Corporation 6 per cent. Debentures 87—92.—Electric and General Investment, shares of £5 (£1 pa'd), 1⅜—2⅛.—Electricity Supply Corporation, Ordinary of £5, 5—5¼.—House to House Company (£5 paid) 1—1⅛.—Do. 7 per cent. Preference of £5, 5⅛—5⅜.—Do. 6 per cent. Debentures of £100, 101—103.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 4⅞—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6⅛—6⅜.—Liverpool Electric Supply, £5 (fully paid) 6⅛—6⅜.—Do. £3 10s. paid, 4⅛—4⅜.—London Electric Supply Corporation. £5 Ordinary, ⅞—1⅛—Manchester Edison and Swan Company £5 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating 6 per cent £100 Debentures, 101—103.—Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid) 4⅛—4⅜. Bank rate of discount, 2½ per cent. (February 1st, 1894.)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

NOTES OF A TRIP TO THE UNITED STATES AND TO CHICAGO—1893. By W. H. PREECE, C.B., F.R.S., Past-President. (*Paper read January 25th*, 1894.)

I.—TELEGRAPHS.

The telegraphic system in the United States is in the hands of two great private telegraph companies, the Western Union Telegraph Company and the Postal Telegraph Company.

The enterprise in telegraph work is evident at once on landing in New York. Every passenger on landing at the dock stage is approached by a messenger from one or both companies, soliciting messages; and on all stages, except that of the Cunard Company, one or other of the telegraph companies has succeeded in establishing an office. The business done at these offices is very great, as, when facilities are thus given to passengers to send messages, nearly everyone wires home his or her safe arrival. This enterprise is evident everywhere.

Competition is intense, but there is no war of rates. A general tariff has been agreed upon, and the only rivalry that exists is in the collection and transaction of business. Dividend earning being the chief end aimed at, only paying commercial stations are properly served. Social and domestic telegraphy is practically ignored, and sparsely populated districts are very inadequately provided for. Hence in the United States telegraph business is neither so general nor so cheap as it is with us. The average price received per message is 15⅔d., as against 7·7d. earned by us. On the other hand, however, it must be remembered that their mean distance is far in excess of ours.

Construction of Lines.

I inspected considerable lengths of the line work constructed by each company, and drove over many miles of a new road line passing through Connecticut.

In this direction American electrical engineers have been very much behind us. They have not built their lines so solidly, nor have they followed true engineering principles in the same way that we have. As a rule, their lines are extremely irregular, being badly constructed with poles, that we in England would not look at. But recently, owing to the difficulty in finding fresh routes, the growth of the number of the wires, and to the absolute necessity for accuracy of workmanship for securing silence on telephone lines, great improvements have been made, and some of the trunk lines put up by the telephone companies, and the new trunk line put up by the Postal Telegraph Company, will compare very favourably with our best modes of construction.

The telephone line to which I have alluded above consists of 16 arms, each carrying 10 wires, or 160 wires in all; the poles are 60 feet high and are placed 100 feet apart. The arms are of pine, and their scantling is 3¼ inches by 4¼ inches, and they are 10 feet long. Owing to the use of wooden pins they are bored with holes 1½ inches in diameter. This weakens the arm, and I observed two instances where arms were broken. A 6-foot arm bored for four insulators costs 15 cents, which is cheap compared with the price we pay. But they are undoubtedly weak, and not to be compared with the oak arms that we use.

As a rule, the poles number 40 to the mile. They are generally of cedar, but sometimes of chestnut. The cedar poles come from Canada and Michigan. Each 25-foot cedar pole costs $2.25, and is said to last 15 years without preparation. The chesnut pole is a little cheaper, and it lasts only 10 years. It is extremely irregular in shape.

American engineers do not adopt the same plan that we adopt in the erection of arms. They are fixed any way, but generally on the modern lines they alternate on each side of the pole. This is done under the impression that it adds strength to the line. I do not know why it should. (We invariably fix the arms on that side of the pole facing London.) Every fifth pole is earthed as a protection against lightning. (We earth-wire every pole.) Stays are very little used indeed, but on new lines they have longitudinal stays in the direction of the wires, one end being fixed at the foot of one pole, and the other end at the top of the next pole. These are called "head guys," and are frequent. Iron poles are used only for electric railways. These are very substantial and look very well. They are made in three sections of simple iron tubes, either 6, 5, and 4, or 5, 4, and 3 inches in diameter respectively.

Copper wire is very much used on telegraph and telephone lines. I saw in the Exhibition at Chicago a form of wire called "tempered copper." This is said to be extremely strong and hard, but it is evidently an alloy of copper, for its resistance is high. I was surprised to find that a compound wire 1·7 ohms resistance per mile, put up by the Postal Telegraph Company in 1883, is still in use, and working well. Our experience of the durability of this wire was disastrous.

Underground Work.

The system of underground work adopted by the telegraph companies in America does not differ much from that adopted by us, excepting that they do not use gutta-percha, owing to its high price. They are using very largely a cable similar to the Fowler-Waring cables, and also kerite-covered wire. Kerite is a form of vulcanised India-rubber.

Offices.

Batteries at all the principal offices in the United States are gradually disappearing. The current for working the circuits is being supplied from dynamos, or from the electric lighting mains. In New York from 30,000 to 40,000 cells have been replaced by dynamos. At Boston 10,000 cells, which cost probably £4,000 per annum to maintain, have been replaced by current derived from the electric light mains at a cost of £600 a year. It must be remembered that the American telegraph circuits are worked entirely on the closed circuit system. They use immense cells, and their cost of maintenance is excessive. We cannot compare their system with ours in this respect, for we use open circuits; and the maintenance of our batteries is certainly, cell for cell, not more than one-fourth or one-fifth that of the United States form of battery.

In New York the Western Union Company have a special plant of 15 small dynamos. In Chicago they have 46. The Postal Telegraph Company in New York are also using dynamos, and in their new station which is being built they are supplying what they believe to be an improvement on the system adopted by the Western Union Company.

We have shown in England that the use of dynamos, owing to the variation of current, is not suitable for high speed working, and I much prefer the plan that we have adopted with so much success in working our continental circuits—namely, the use of accumulators. Accumulators have an immense advantage over dynamos; they store up energy, so that in the event of any accident or breakdown of machinery the accumulator maintains the circuits working. The accumulator is not in motion. There is no machinery to fail or to break. There is nothing to stop, and little to get out of order. But the chief advantage of the accumulator is the absolute steadiness of its voltage. There is also economy in capital expenditure, and I am quite convinced that the Western Union Company in New York would have effected considerable economy if they had used accumulators charged by the electric lighting plant, instead of supplying the elaborate series of engines and dynamos now working their circuits direct.

At Boston and other stations a very well made and well designed motor-dynamo is supplied by Messrs. Crocker-Wheeler. They are primarily motors worked on the 110-volt electric lighting service, driving a small dynamo, and they transform this down to a voltage which will charge any number of cells required. This system is in use by all the telephone companies, and, as I will point out when speaking of telephones, the service is much improved by the use of accumulators thus charged.

Apparatus.

The working of the Wheatstone system between New York and Chicago is admirable. The grand total of messages handled in one day on this circuit is certainly astonishing. 4,211 messages have been passed between these two places on one circuit in a day—a number that we can scarcely hope to rival.

The reason for this is not the greater speed at which the apparatus is worked—for the speed is less than ours—but to the fact that the business day in the United States extends over a much greater number of hours than with us. The business day in New York commences three hours before that in San Francisco, and the business day in San Francisco extends for three hours beyond the business day in New York. Hence the business day, which in England scarcely extends telegraphically to four hours, in the United States extends probably to 12 hours. Thus the number of messages handled is much greater per day than with us.

The advantage of Wheatstone working to the company was illustrated while I was there. On August 29th, a cyclone in the eastern part of the States prostrated the poles and wires for miles throughout half a dozen States. Three Wheatstone circuits were maintained working—and working badly—between Chicago and New York by means of repeaters at Buffalo and Pittsburg, but on these three circuits 8,693 messages were handled. This was the only means of telegraphic communication between the Eastern and the Western States. Curiously enough, the new and strong long-distance telephone line was not broken down.

Pneumatic Tubes.

The only novelty in pneumatic tubes that I saw was that on trial between the Post Office at Philadelphia and a sub-office in Chestnut Street. This is a line of two pipes, 6½ inches in diameter and 5,792 feet in total length—that is, a distance between the two offices of 2,896 feet. The carriers are metal cylinders whose inside dimensions are 16 inches long and 5½ inches in diameter. They weigh 6 lbs. each, and carry 120 letters. The carrying capacity of the line is said to be 180,000 letters per hour, but I think this is exaggerated; the time taken by a carrier in transit is 55 seconds, and the air pressure is maintained at 7 lbs. per square inch.

The line has been working since February 17th, and it has been used for the transmission of letters, the whole service to this particular sub-office being done through the pipe.

The pipe is continuous, and a current of air is constantly flowing through it. Twenty-five horse-power is absorbed in maintaining this current at the pressure required, and the carriers are said to move at the rate of 40 miles an hour. Twenty-five carriers are in use.

Conclusions.

It is quite impossible to inspect the telegraph system of the United States and compare it with our own system without drawing comparisons between the way in which the work is done in the two countries. The result of my previous visit was to confirm my view that we do our work better in England than they do in the States. Our apparatus is better, our speed is higher. Messages are handled with greater reliability. A message can be sent and its reply received with certainty in an hour in England. I fancy such rapidity would astonish the users of the telegraph in the States, except those in such busy centres as New York and Chicago, and generally the speculative branches of the community.

The domestic telegram scarcely seems to have reached the United States, and this is owing, probably, to the fact that the districts of private residences, the small towns, and the villages do not possess

telegraph offices, unless they are supplied by the railway company at the railway station, or by the Western Union Company, who do the work for the railway company.

I fail to see any superiority in the manipulation skill of American operators. They certainly have not made the same advance in technical education that we have, and altogether it may be said that the management of the telegraphs in the States in the hands of private enterprise does not compare favourably with the management of the telegraphs by the State at home.

The management at home is characterised in all particulars with similar energy to that which I observed in the States; and I come back without any views or wrinkles which I think could be impressed with advantage on the commercial or technical management of our system at home, unless it be the encouragement of offices in hotels, for it is found everywhere that a telegraph office at one's door prompts the desire or want to telegraph.

II.—Telephones.

The business of telephony in the United States is a gigantic monopoly in the hands of the American Bell Telephone Company, whose headquarters are at Boston. This company owns more than one-half the stock in every telephone company in the States. It holds itself the whole of the stock of what is commonly known as the Long-Distance Telephone Company, but which is really entitled the American Telephone and Telegraph Company, and thus by having control of the stock in every company it maintains the power and monopoly. The advantage of this monopoly is the establishment of a uniformity of working and practice that is highly and extremely beneficial. The form of apparatus used, the mode of working, the details of construction, and all the methods in use are dictated from Boston. The result is little or no friction; and while each independent company is self-managed and self-contained, nevertheless it is subservient to the direction and control of headquarters at Boston. There is no divided responsibility in the United States. Every town has but one system. The result is that the service is thoroughly and perfectly performed. In those parts of the country where metallic circuits have not yet been adopted there may be defects in working, but these are rapidly being removed, for the benefit derived from metallic-circuit working is being felt everywhere in the United States.

Exchanges.

It is found in the States that multiple boards can become too large, too unwieldy, and they introduce troubles of their own that have to be remedied. These defects are aggravated when there are several exchanges in the same city. In Chicago Main Exchange 25 per cent. of the business, in Harrison Street Exchange 94 per cent., is trunked out. The average trunking is 50 per cent. A multiple board is, therefore, useful for only 50 per cent. of the work done. It should be explained here that the term "trunk" is adopted in America to indicate connections effected between one exchange and another within the same area. Connections between town and town are designated "long-distance" connections. The tendency is to depart from the principle of the multiple switch; and an extremely interesting experiment is being carried out simultaneously in Chicago, Buffalo, and New York to determine the merits of a new system of working called the "divided board." The divided board means this: There are two boards, the one called the *answering* board, and the other the *connecting* board. The answering board contains the indicators and trunks, including those to the connecting board, and all local connections are treated as trunks through the connecting board. Thus, while each operator at the answering board attends to and answers only her 60 subscribers, and is able still to control all the trunk wires, the local spring jacks are duplicated on the connecting board, which may contain one, two, or three complete sections, as the case may be, and are attended to by separate operators. All the business is thus trunked. The result is that the service performed for the subscribers for local connections is slightly retarded. On the other hand, the work done on the trunks is equally expedited. If 50 per cent. of the work done in the Central Exchange is trunk work, it is argued that, if subscribers find that one-half of their work is expedited and the other retarded, the expediting of the more important part will compensate for the retardation of the less important, and the general result will be beneficial.

The chief merit of the divided board is that it reduces the "jacks," as the switch holes are called. Seven sections of board with 42,000 jacks would replace 40 sections with 240,000 jacks in an exchange of 6,000 subscribers. I find opinion, however, divided upon this question; but the view is very general that when the multiple switchboard exceeds a capacity of 2,500 subscribers it certainly introduces disadvantages and defects which must in some way or other be remedied.

Trunk Working.

The trunk working is wonderfully well done. In the first place, the connections between the different exchanges are very numerous. In the Central Exchange at Chicago there are 344 outgoing and 325 incoming trunks. There are 11 exchanges, and these exchanges are located as nearly as possible in the centres of the districts which they are designed to serve. The business of these offices, however, is by no means self-contained, and a very great amount of their work is in handling calls from subscribers in one exchange to subscribers in another.

The long-distance work is done in the same way. Only metallic circuits are switched on to the long-distance lines. The incoming trunk wires end in plugs, the outgoing trunk wires end in "jacks," so that when an operator hears "351 on Chicago 3," he simply takes up 351 plug and puts it in a Chicago jack without hesitation. If, however, all the Chicago jacks are busy—which he sees at once by the visual signal—he says, "Busy," and the caller has to wait his turn. In my experience this occurred but rarely. When the calls were heard, the connections were made as rapidly as possible for it to be done, or as rapidly as one could wish that it should be done.

In New York the Long-Distance Company and the New York Telephone Company are in the same building. A complete section of the New York multiple board is in the long-distance switch room, so that connections are made *direct* between the long-distance lines and the subscribers. Usually a section of the multiple board in the local exchange is allotted for long-distance trunk work to the long-distance office, which may be elsewhere. It is so arranged that when a subscriber talks on a long-distance line his own circuit is entirely cut out from the local operating switchboard.

There are a great many public call offices open in every city. There are 535 in New York. They call them "public pay stations." People pay tolls, and they come in and speak to the exchanges and get their connections through.

Long-Distance Working.

The long-distance speaking in the States is very popular and very successful. The opening of the circuit between New York and Chicago—a distance of nearly 1,000 miles—was so successful that they immediately found it necessary to erect two more circuits. There are now, therefore, three circuits between these two places. I tested these circuits, and found the working remarkably good. It was difficult to say that it was better or worse than the working of our London-Paris line.

The tariff for the long-distance work is based upon one cent per mile for 5 minutes' talk. The greatest distance that I found upon which speech was conducted was between Milwaukee and Portland, and between these places talking costs 11 dollars (44s.) per 5 minutes.

Underground Work.

The statistics that I have given show how rapidly underground cables have come into use in the States. At the Chicago Central Exchange 76 cables, each containing 100 wires, enter the building and ascend up a shoot to the exchange room. The conductor used is smaller than that adopted by us. It is only No. 19 Brown & Sharpe gauge. It gives 47 ohms resistance per mile, and it has a capacity of 0·68 microfarads per mile. The insulation must be 500 megohms per mile at 60° F. All cables before being used are very carefully tested, not only to see that they comply with the specification as to conductivity, capacity, and insulation, but also for what is called "cross-talk," by means of buzzers.

There are no less than 14,034 miles of underground wire in New York. 160 cables, each containing 100 wires, enter Cortlandt Street building—that is, 16,000 wires enter this exchange. In Boston 91 lead-covered cables enter—that is, 10,920 wires in all, for each cable carries 120 wires.

The cables are made for 50, 60, or 100 pairs of wires. The 50-pair cables have a diameter of 1¼ inches, the 60- and 100-pair cables being 2 inches and 2¼ inches in diameter respectively. These cables are in all cases brought straight to distributing boards in a room alongside the switchboard room, and here they are brought to terminals in a way similar to that adopted by us, so that changes can rapidly be made.

Subscribers' lines are so distributed among the sections of the switchboards that the work is distributed as uniformly as possible amongst the different operators.

The dry-core or paper insulated cable has proved to be a very great success, and is now universally adopted for telephone purposes.

Disturbances.

The disturbances in telephone circuits created by the extension of electric railways have been severely felt in many parts of the United States. We have experienced the same in London, Liverpool, Leeds, and Blackpool. But owing to the prompt action taken by the telephone companies, especially in Boston, the area of disturbance has been much reduced, and the influence of electric railways on telephones has ceased to be a trouble. Of course this result is very much favoured by the rapid introduction of metallic circuits into cities; but it has also been favoured by the prompt action of the railway companies themselves. They did all that they were asked to do, and that at once. In all cases the negative pole of the dynamo at the generating station is put to earth, and the return conductors have been enlarged. Extra copper wires have been buried between the rails, and heavier conductors have been put upon the poles. The return conductor is the largest size copper wire made, viz., No. 0. The rails have been bonded together and to this return conductor; and in Boston the rails are welded electrically, which is very effective. I was, unfortunately, unable to see this electric welding in operation, for the transformer had broken down, and was in the shops under repair. I saw the whole apparatus, however. A special car is used for the plant, and the system adopted is extremely satisfactory.

The electrolytic action of these disturbing currents has been noticed not only as affecting gas and water pipes, but also the lead coating of the telephone companies' cables. I have seen several specimens of lead pipes much pitted. I have reason to believe that the remedies adopted to cure disturbance will also put a stop to what might have become an element of great danger to underground cables.

Lightning Protection.

A very efficient system of lightning protection has been introduced upon the telephone system, not so much to protect the system from the effects of lightning, as from the effects of those powerful stray currents that enter a telephone circuit when accidental contacts occur between it and electric light and electric railway conductors. Such contacts have been frequent, owing to the prevalence of overhead systems, but they are diminishing now that conductors are placed underground. They have resulted in numerous accidents, and several telegraph and telephone offices have been set on fire and the apparatus destroyed. Every telephone circuit is now protected by a fuse, or cut-out—a fine wire of great resistance, which melts if traversed by a

powerful current; also by an airspace protector on the same principle as the lightning arresters we use, but having carbon plates instead of brass plates; and, finally, by a small heat coil, which puts the current to earth in a very ingenious way when the stray currents exceed a certain strength. These three guards have been found quite effective. No accident has occurred where they have been used.

The present generation in America has grown up with the telephone. It has become a factor of business, and absolutely essential to the transaction of that business. Its use has passed its climax; it has reached its normal stage. There is no touting for business; business comes. Every new office must have it. The working is excellent, and they are alive to the necessity of maintaining its efficiency at the very highest point. Education is complete, not only of the staff, but of the customer. The apparatus itself is being perfected. Uniformity of practice is being introduced under the operation of the paternal control at Boston, and the influence of technical education and of technical institutions is being felt everywhere.

I find a group of highly educated, clever young electricians being engaged and encouraged by the telephone companies. New blood is being introduced, and great zeal and activity is shown.

III.—The Electrical Congress.

Two Congresses were held at Chicago—the one, a general one, to which all electricians were invited; and the other, called "The Chamber of Delegates," to which nominees from the different Governments were sent. The latter was the more important of the two, but each secured considerable attention, and they were distinctly great successes. The following extract from an American technical journal very fairly summarises the results:—

Perhaps the most useful result of the Congress was the bringing together of such an international mixture of electricians, making friendships, allaying jealousies, and breaking down national prejudices. Electricity is the only branch of science which has but one language, and it is now quite cosmical in its character.

Congresses do infinite good in promoting friendliness among nations.

Chamber of Delegates.

The object of this meeting was really to consummate the work done by the British Association and by the Board of Trade, and to secure the official sanction of the United States Government to the units selected and adopted in England. This was done, and the report of the Chamber gives international support to the proposed legalisation of the ohm, volt, farad, ampère, watt, and joule, as defined by the Committee of the Board of Trade. There is no doubt that all European Governments will now accept these decisions.

A new unit was adopted, viz., the "henry," a unit of induction, which was sometimes called the "quadrant," as defined in Paris in 1889, and sometimes the "secohm," as proposed in England. The acceptance of the name "henry" pleased the Americans very much, for their nationality has hitherto been unrepresented among the celebrated electricians whose names have been applied to the standards of electrical measurements. Germany, Italy, France were represented by Ohm, Volta, Coulomb, and Ampère; while England absorbed no less than three, viz., Faraday, Watt, and Joule. America has now her Henry, and is satisfied.

An attempt was made to introduce other units, but the feeling is pretty strong that language-framing electricians must rest on their oars for a time. New ideas and new measurements must have new terms and new names, but the general public must become more accustomed to the new language already invented before proceeding to manufacture more novelties in phraseology. The new terms are even now very difficult to explain, and still more difficult to understand. Moreover, electricians themselves are not sufficiently unanimous either as to the necessity or upon the accuracy of the definitions of the new conditions, and therefore they can afford to wait for a final settlement for another congress some years hence—perhaps in Paris in 1900.

IV.—The Exhibition.

Nothing grander in design or more beautiful in execution has ever been seen in this world than the group of buildings situated in Jackson Park, Chicago, and called the "World's Fair." It is a great misfortune that the world did not appreciate, nor respond to, the ambitious views of the conveners of the fair. Their conception was magnificent. Their architects if they did not originate the plans, certainly rose to the occasion. Their builders realised their views. Every possible convenience and accommodation was provided for exhibitors, but the response was poor; and the internal management of the whole business, owing to the inexperience and, perhaps, overweening confidence, was indifferent. The success of the undertaking hovered for some time over failure; but fine weather, patriotism, novelty, real beauty, and cheap fares at last attracted crowds, which, numbering about 200,000 a day, have converted what looked like a disaster into a well deserved success. I have not much to say of the Exhibition as an exhibition. It was very like its predecessors. It did not attract me; for, having taken part in nearly every exhibition for the last 15 years, I am sick of exhibitions. I devoted much attention to the electricity building, and observed there several novelties, some of which I have referred to in other parts of this report.

Gray's telautograph attracted much attention. It is an improvement on Cowper's writing telegraph. It reproduces the motion of a pen, so that while you are writing in London a phantom hand seems to guide the pen and reproduce your own writing in Nottingham. You can see the pen move, dot the i's, and cross the t's. It makes corrections and erasures. It works well, but very weirdly. My writing and signature were clearly reproduced at the very first trial. But it is immature for practical trial at present. It has not reached its final stage. It is being improved every day. It is very complicated in construction, and it requires four wires to work it. The Western Union Company in Chicago have established a circuit between their head office and stores department, and are giving it a good test.

The French and German Administrations sent admirable and extensive displays of their historical and working apparatus, with a very large staff of men to attend to them, but I am pleased to say that our exhibit proved much more attractive and interesting. It was better arranged and more complete; and our one solitary assistant, Mr. J. Chapman, won golden opinions by the admirable way in which he attended to his duties, and by the excellent verbal explanations he gave of our show.

The United States of America made no historic exhibit, but the Western Union Company showed many relics and examples of Morse's early work.

The American public were surprised to find how much we in England had anticipated their work. Morse's first message, "What has God wrought?" was sent only in 1844. Our history commenced in 1837. Our jubilee was celebrated in 1887; theirs is to be celebrated this year.

An exhibit that attracted much attention was a door which opened before you as you approached it, and closed behind you as you receded from it. This was done by a small electric motor which was set in motion when you stepped on a mat, and released when you passed through the door. It was worked with the same current that would light a glow lamp.

England is the home of the alternator, but it has now taken firm root in America. In 1884 there was not a single one to be found in Philadelphia. Now they are everywhere, and alternate currents are being studied and developed in a way that is completely putting our experimentalists in the back row.

The paucity of real novelties, or of what are commonly known as "Yankee notions," was very marked. The necessity for such things—that is, the scarcity of labour—has apparently disappeared, and with its parent the child has languished. Moore's spark-interrupter—an automatic vibrating armature in a vacuum tube, by which glow lamps can be turned up or down without wasting energy—was described at a meeting of the electrical engineers at New York, but I did not see it at the World's Fair.

The distinguishing feature of the Chicago World's Fair was not alone its uniqueness, but its grandeur and its magnificence. It was not an exhibition of goods and manufactures in the old-world sense. No one seemed to care two straws for the mere trade exhibition *per se;* he admired the beautiful buildings, the water-ways, the external attractions, and, above all, the congeries of people that assembled from all quarters of that great continent in such multitudes.

The distinguishing feature of American engineering is the great scale on which it is carried out, and the rapidity of its adoption. An electric railway from Chicago to St. Louis, 250 miles long, is not a difficult engineering feat, for the country is level, but it is novel for the fact that it is projected to travel at the rate of 100 miles an hour.

V.—Electric Lighting.

Electric lighting has not generally made the rapid progress during the past nine years in the States that was expected from its great rate of growth during the previous four years. Wild speculation, hasty construction, fatal accidents, and frequent failures have reacted on steady progress. At the same time the advance has been very great, principally in public street lighting. All towns and villages in all parts of the country, however small and isolated, or however distant, seem to have adopted public arc lighting. Arc lamps are found suspended over the roadways in a very rough and ready way, sometimes from stretched wires, sometimes from long balanced levers, but always effective.

The arc lamp-posts are generally of timber, like telegraph poles; occasionally squared timber, as in Broadway, New York; and sometimes plain and neat iron poles, made of differing sections of iron pipes, but rarely so heavy, massive, artistic, and expensive, as in England. Clear glass globes appear to be almost universal in use. It is quite rare to see frosted glass or opaline shades.

The principal novelty introduced has been the use of flat carbons of oval or elliptic section, to increase the duration of the light. They are 310 millimetres long; the major axis is 25 millimetres, and the minor 11 millimetres. The ordinary arc lamp burns as a rule only eight hours, but this flat carbon doubles its life. Moreover, the flat carbon is found very advantageous and useful with alternating current systems, on which arc lamps as a rule work badly. The standard current used is 10 ampères, and the energy expended varies from 400 to 500 watts. The lamps burn very steadily as a rule, and give a light of about 800 candles at the angle of maximum intensity.

An excellent self-regulating alternator for public arc lighting, designed by Stanley, was exhibited by the Westinghouse Company. It maintained its current quite constant, however much the number of the lamps was varied between 0 and 24. Any number could be turned on or off without the least difference being detected in the current on the light.

Incandescent Lighting.

Glow lamps are, within my observation, invariably used in telegraph offices, post offices, telephone exchange rooms, hotels, and in many railway stations.

The electric light is more general in such public places than with us. I did not visit a single place that was not so fitted, and with glow lamps. In private houses it is much used, but not so generally as with us. In Chicago the residential lighting is only 33 per cent. of the total. In all large cities there are immense blocks of buildings fitted with lifts and used as offices. In all cases they were lighted by their own isolated plants. One of the most striking features of a bird's-eye view from some lofty spot of a great city, like New York or Chicago, is the white, fleecy, wool-like jets of vapour that float gracefully away from the top of every large building. They are to be

reckoned by the hundred, and every one means steam plant working lifts and electric light. The Western Union Company at New York and Chicago have their own steam plants.

When I visited Chicago in 1884 no central electric lighting station had been built, and no current was supplied. Now, a capital of $2,233,000 earns an income of $320,000 yearly.

The glow lamps (16-C.P.) fixed are	136,403
Arc lamps fixed	4,376
Motors supplied—total H.P.	3,612

and this is equivalent to 430,000 10-C.P. lamps fixed, or such lamps as we reckon with in England.

The maximum load is 50 per cent. of these lamps alight at one time, which accords with our experience in England.

The price works out at 7½d. per kilowatt-hour, or supply unit, and this includes the cost of the renewal of the lamp. The cost of production works out at 3½d. per unit. The cost of the production of electric energy in the States differs, therefore, very little from that experienced here. It is steadily on the decrease. As the load increases, as the daily supply lengthens in duration, as the generators increase in size, so will the cost diminish; and how low it will fall no one can predicate. Anyway, it will certainly far exceed in economy the production of gas.

The price of lamps to the undertaker—that is, to the electric light company—is 1s. 4d.; the life of the lamp is 600 hours. A 16-C.P. lamp takes 0·45 ampères and 110 volts. It is, therefore, a 50-watt lamp, and a better one than we get at present in England. The screw socket appears to be in universal use. I wish it were so here.

There are three central stations in Chicago. A new station is being built alongside the water in Harrison Street with a capacity for utilising 20,000 H.P., where every modern appliance for cheap fuel, automatic feeding, condensing, and economising will be used.

The south side central station is worked by natural gas, which is brought in pipes 100 miles long from Indiana. It is very cheap compared with coal.

I found in use in Chicago a system of raising the voltage on the feeders when the pressure falls, owing to the increase of load, by switching in motor dynamos. They have given the name of "boosters" to these instruments. A somewhat similar system has been applied at the Midland Railway, Derby.

The accumulator in America has been a failure for electric lighting, and a very strong prejudice exists against its use. It has led to much litigation, and the best forms seem little known there. The lagoons of the World's Fair grounds were, however, very successfully navigated by extremely pretty electric launches, worked and lighted by accumulators. The grounds at night, brilliantly illuminated and interlaced by winding waterways, with wooded islands and pretty bridges, along which illuminated gondolas and silent launches floated noiselessly, formed most beautiful and fairy-like scenes, superior to anything seen in Venice or pictured by art.

The feature that distinguishes American from English practice is the persistent use of belting and countershafting. In some stations the belting was to English eyes appalling. Direct-driving is only now making its way. There were several direct-driven engines and dynamos exhibited in the American section at the World's Fair, and some new stations now being built are to be direct-driven. The Willans & Robinson engines on show at the exhibition, and a steam turbine exhibited in the Swedish section by Laval—a form somewhat similar to that of the Hon. Charles Parsons, who unfortunately did not exhibit—attracted much attention. The reports of our performances in England are much sought after, and I think one influence of the Chicago gathering will be to convert American engineers to direct driving.

VI.—Electric Railways.

The progress made in the establishment of electric railways is the most wonderful instance of growth of electric industry observable in the States. In 1884 I found only one railway so worked, and that experimentally, at Cleveland. Now every town has its electric railway. There are 4,000 miles of lines so worked, 6,900 motor cars, and 4,000 trailing cars.* The capital embarked is $13,000,000, and the rate of progress is scarcely checked by the serious financial depression that has passed over the country.

Electrical appliances of all kinds for railway working were among the most conspicuous exhibits at the World's Fair. A special track was laid down for test and trial, and along here I inspected a 30-ton locomotive, the heaviest yet made, having a horizontal pull on the level of 6,000 lbs., or enough to draw 500 tons on an ordinary English railway.

The type of railway in general use over the United States of America is very uniform. We have only one true example in England, and that is at Leeds. A modification of the system has, however, been adopted on the South Staffordshire Tramways, and is about to be introduced in Coventry. The wires are all overhead. A heavy insulated copper wire is suspended over the centre of each pair of rails, or "track," and called the "trolley" wire. This conveys the current from the power house. It is picked up by a trolley rod, which presses, by the action of a spring, upon this wire, and so conveys the current to the motors, which are geared to each of the two wheel shafts of the car. The current is thence transmitted through the wheels to the rails, and it returns thence to the power house by heavy copper returns buried in the ground or suspended on the poles.

The maximum number of cars on at one time is nine motors and nine trailers, and this averages at the power station 13·7 H.P. per car running. The cars run on the straight at from 16 to 20 miles an hour. The rails are 85 lbs. per yard—a very heavy rail for a tramway. The usual rail is 52 lbs. per yard, as at Boston; but experience in the United States of America is leading to heavy rails. The pounding and hammering on the rails with heavy loads is very great, and in Philadelphia they are using even 90-lb. rails.

The trolley wire alone is not unsightly, but when it is protected with three guard wires, as at Boston, and the same poles carry the feeders, it becomes hideous, and it is astonishing that the American community submit to it. Such a system is impossible in England.

This trolley wire must be elastic, otherwise the trolley itself frequently jumps off and stops the car. Attempts have been made to improve the appearance of the road by using handsome central iron poles, with solid brackets on each side to carry the two trolley wires, but the want of elasticity has introduced fresh evils. The trolley frequently comes off, and great sparking is evident.

I saw the electric snow ploughs used to keep the tracks clear in wintry weather.

The system of railway working in Boston has given such satisfaction to the public that the traffic returns have improved 30 per cent. owing to the change from horses to electricity. The service is so much quicker, cleaner, and better performed. A railway car in full service is said to run an average distance of 250 miles a day, and its mean speed is 15 miles an hour.

There is an important question under discussion in the United States of America—whether it is better to pursue the present practice of using two motors, one on each axle wheel, or to use only one motor connected electrically and flexibly with the wheels by bevelled gearing. This is the plan advocated and practically carried out by Mr. Sperry. The weight is thus placed in the middle. The horizontal pull is said to be greater. The starting torque is smaller. It is more easily controlled. There is no slip, and the velocity of all parts is uniform. It will climb a stiffer grade. One 35 H.P. motor replaces two 30 H.P. single reduction Thomson-Houston or Westinghouse motors with economy of energy. The system is working in Pittsburg, where it was adopted after a very severe trial with a Westinghouse car, and it is about to be used on 22nd Street in Chicago. It has this disadvantage—that if the motor fails there is not a second one available to take the car home. The problem is an interesting one, and its solution will be watched with great interest, for it has an important bearing on the economies of our English roads.

The feeling is pretty prevalent in the States that the conductors must eventually go underground. Experiments in this direction are being made in several directions, notably in Washington and Chicago. The trolley with its guard wires is really an abomination, and the disturbances created by insufficient return accommodation are annoying the telegraph and telephone interests, and alarming the gas and water companies. The future working must be metallic circuits and underground conduits. It is so done in Buda-Pesth, and it has been partially done in Blackpool and in Rome. Other experiments are contemplated in England. No one can doubt that the future of electric railways is very bright. The South London Railway and the Mersey Dock Elevated Railways are examples of great successes in England, but it is in the States, where this form of locomotion has become a necessity, that we are sure to see a speedy and practical solution of the problem.

Conclusion.

I cannot too gratefully speak of the attention and kindness I received from everyone, and I certainly feel that I have personally profited from my visit very much indeed.

A visit to the United States is something like charging an accumulator. It stores the visitor with energy. When I am discharged, and my adverse criticisms have been forgotten, I shall probably cross the Atlantic again.

* Trailing cars are not fitted with motors. They carry passengers only, and are drawn by motor cars.

NEW PATENTS—1894.

1,320. "Improved electrical insulated fitting." C. C. Connor. Dated January 22nd.

1,327. "Improvements in steam turbines." H. W. Houlden. Dated January 22nd.

1,356. "Improvements in electrolysis." E. Andreoli. Dated January 22nd.

1,375. "Improvements in rapid telegraphic transmission." C. Langdon-Davies. Dated January 22nd.

1,417. "Automatic device for removing resistance in starting electric motors and replacing same." G. H. Whittingham. Dated January 23rd. (*Complete*).

1,433. "Apparatus for advertising by means of electric lamps." W. F. King. Dated January 23rd.

1,440. "Improved electric battery." J. Peel. Dated January 23rd.

1,461. "A detachable car-piece or device for use in connection with the phonograph." H. M. Edwards. Dated January 23rd.

1,473. "Improvements in dynamo-electric machines." H. H. Lake. (Communicated by G. F. Dieckmann, United States.) Dated January 23rd.

1,478. "Improvements in connection with phonographs, grammaphones, graphophones, and similar sound-recording and reproducing instruments." J. L. Young. Dated January 23rd.

1,479. "Self-acting hydraulic apparatus for winding up mechanisms actuated by weights or springs, such as Hughes's telegraphic typewriters, Morse telegraphs, &c." R. H. Gould. Dated January 23rd. (*Complete.*)

1,491. "Improvements in arc lamps." J. B. Barton. (Communicated by W. Jandus, United States.) Dated January 23rd.

1,495. "Improvements in commutator brushes." W. L. Wise. (Communicated by O. Hering, Germany.) Dated January 23rd.

1,532. "An improved system of metering electric currents." E. G. Pink. Dated January 24th.

1,542. "Improvements in or relating to facsimile telegraphy." H. W. C. Cox and R. J. Crowley. Dated January 24th.

1,581. "Improvements in and relating to gas engines." L. Benier. Dated January 24th. (*Complete.*)

1,582. "Apparatus and process for converting heat into motive power, or electricity, or both, and for cooling and refrigerating." F. Stone. Dated January 24th.

1,594. "Improvements in steam turbines." D. Cook. Dated January 24th.

1,657. "A method of and apparatus for communicating electricity to vehicles." H. P. Holt. Dated January 25th.

1,686. "Improvements in propelling locomotives by electricity and in apparatus therefor." R. Kennedy. Dated January 26th.

1,695. "Improvements in telegraph signal codes and apparatus therefor." S. D. Williams. Dated January 26th.

1,698. "Improvements in telephone transmitters." R. Steenberg. Dated January 26th.

1,701. "Improvements in and connected with electric conduits." C. R. G. Smythe and A. H. Dunnachie. Dated January 26th.

1,744. "Improvements in electro-deposition." W. S. Rawson. Dated January 26th.

1,776. "Improvements in electric arc lamps." W. A. Walton. Dated January 27th.

1,788. "Improvements in electric glow lamps." J. P. Bayly. (Communicated by W. Wiklund, Sweden.) Dated January 27th.

1,794. "Improvements in electrical traction or electrical railways and tramways." W. Adkins. Dated January 27th.

1,798. "Improvements in electric signalling apparatus, and in apparatus connected therewith." J. W. Fletcher. Dated January 27th.

1,810. "Improvements in electrical measuring instruments." H. E. S. Holt. Dated January 27th.

1,814. "Improvements relating to steam and other turbines." A. W. Wheildon. Dated January 27th.

1,849. "An improved arc lamp." F. Taylor. Dated January 27th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

23,460. "Improvements in electro-motors." H. T. Barnett. Dated December 20th. Claims:—1. An electro-motor consisting of two commutation magnets and their appurtenances, substantially as described. 2. In an electro-motor, consisting of two commutation magnets and their appurtenances, the combination therewith of an inter-gearing device, consisting of a gear wheel attached to each commutation magnet and a third gear wheel free to revolve upon a fixed bearing or axle, substantially as and for the purpose described.

23,774. "Improvements connected with the obtainment of the electric arc for lighting and other purposes, and in apparatus therefor." R. Niewerth. Dated December 24th. Claims:—1. In apparatus for the production of an arc flame, the arrangement of several carbons, insulated one from the other and parallel to one another in a circle, arranged to be revolved, and means by which the different carbons receive positive and negative current alternatively, while at least two of the carbons are intermittently without current, substantially as described and illustrated. 2. In apparatus for the production of an arc of flame, the arrangement of several carbons preferably placed in a circle parallel to each other and insulated, and revolving means by which the different carbons will receive positive and negative current alternately, while at least two rods are intermittently without current, substantially as described.

1893.

449. "Improvements in or relating to electric motors." I. E. Storey. (Under International Convention.) Dated June 9th, 1892. The inventor constructs the field magnet in the form of a cylinder adapted to surround a coil or coils of wire, and having pole pieces extending inward from a point or points about midway between the edges of the said cylinder, and extending laterally in both directions towards the edges of the cylinder, so as to embrace the coils. 4 claims.

1,229. "Improvements in secondary or storage batteries." H. H. Lloyd. Dated January 19th. The improved battery plate or electrode comprises a perforated conducting support, having pieces of active material or material adapted to become active, as cast chloride of lead, with or without an admixture of chloride of zinc, supported in perforations thereof. 6 claims.

1,449. "Electrical hose signalling apparatus." W. Fowler. Dated January 23rd. Consists in an attachment whereby a third bell, carried by any person, or located at any desired point, may be placed in the circuit at any coupling joint of the hose, whereby the three bells are all placed in the same circuit, and simultaneously operated by pressing a button at any point. 4 claims.

1,759. "Improvements in electrical apparatus for use in ships' telegraphs and other purposes where only certain fixed signals are to be transmitted." G. F. Flemmich. Dated January 26th. The transmitter consists of a number of pairs of insulated contact points, one of each pair being carried by a spring, the other being a fixed metal stud. The several pairs are firmly secured to an insulating base, and are so arranged that the spring and stud comprising the same are normally apart, but so arranged that any pair can be connected by a metal contact piece which is carried by the axis of the instrument, and is of such a width that when the handle which is fixed on the end of the axis and moves the same round with itself is moved to stand over any one of the several signals, the corresponding pair of contact points are brought into connection. The receiver is similar in construction to the transmitter, but with the difference that the pairs of contact points are normally in contact, but so arranged that the movement of its handle separates each pair as it reaches them, this being effected by an attachment on the axis which lifts off one by one as it passes through them the springs which normally hold together in contact the pairs of studs. Practically, the corresponding pairs of contacts in both instruments form parts of as many different circuits of which only one can be closed at one time, that is when the handle of the transmitter is moved to any given signal. An alarm will then sound, and continue to sound, till the handle of the receiver is moved to the corresponding signal. 2 claims.

2,059. "Improvements in or relating to telegraphy." A. Heil. Dated January 30th. Consists particularly of the substitution of the hitherto used clockwork for uniformly advancing the band of paper by a device which is actuated by the current serving to transmit the telegram. 5 claims.

2,361. "An improved depolarising material for galvanic elements." F. Szymanski. Dated February 2nd. Claim:—A depolarising material for electric elements consisting of manganic chloride, $Mn_2 Cl_6$, or manganic fluoride, $Mn_2 Fl_6$, which compounds are mixed with air-dry or chemically inactive substances, such as cellulose, carbon, graphite, peroxide of manganese, and the like, substantially as described.

2,455. "Improved friction coupling for the carbon-feed mechanism of electric arc lamps." J. Jergle. Dated February 3rd. Claim:—An improved friction coupling for the carbon-feed mechanism of electric arc lamps, characterised by the combination with a cross-head carrying the positive carbon of a vertical screw threaded rod engaging an open nut on the cross-head, a horizontal disc on the upper end of the rod actuated by a step-by-step feed, consisting of an armature lever pivoted on the rod, a shunt magnet parallel to the lever, and a pair of roller clutches, each of which under the action of the shunt magnet and its armature is adapted to alternately engage and disengage the disc to rotate it, substantially as described and shown in the drawings.

2,586. "An improved diaphragm for electrolytic cells." C. N. Waite. Dated February 6th. Consists in a diaphragm composed of asbestos or other acid-resisting fibrous material containing in its pores bi-chromatised gelatine. 1 claim.

2,672. "Transmission of power by high potential direct currents of electricity." C. S. Bradley, R. T. McDonald, and R. S. Taylor. Dated February 7th. Consists in placing a large number of generators in series relation, and thoroughly insulating them both from earth and from one another, and transmitting the combined electromotive force of all the machines to line. 7 claims.

2,696. "Improvements in telautographs or writing telegraphs." P. A. Newton. (Communicated from abroad by Elisha Gray, of America.) Dated February 7th. Relates chiefly to an improvement in the transmitter whereby the pulsations through which the receiving pen is operated or controlled are sent to line. It is important in a transmitter to secure certainty of contact in the circuit making and breaking device, rapidity of movement, and small liability to deterioration through friction of parts. These advantages are secured in the present invention by employing a vibrating circuit maker and breaker operated magnetically through the making and breaking of a magnetic circuit or circuits, in turn controlled by the movements of the transmitting pen. 27 claims.

3,200. "Improvements in fixing electric conducting wires to the insulators supporting same." P. R. Schomburg. Dated February 13th. Consists in means for mounting and fixing wires to their insulators, so that the stretched conductor can be fastened to the insulator without binding wires, and in such a simple and effectual manner that same can be done even by unskilled labour. 1 claim.

3,398. "An improved insulating material for electrical purposes, and method of preparing same." A. Gentzsch, J. Goldschmidt, and E. R. von Scanavi. Dated February 15th. Consists of about 38·5 parts of shellac, 38·5 parts of colophony (rosin), 3·8 parts of birch tar oil, 3·8 parts of aniline oil, 15·4 parts of $C_{14} H_{10}$. 5 claims.

3,461. "A new or improved writing desk and paper roll holder combined for telephones." C. G. Nestler. Dated February 16th. Claim:—A combined writing desk and paper roll holder for telephones, consisting of the arrangement and combination of a desk for telephones, with an upwardly moving strip of paper stretched on the desk for the purpose of being written upon, and means for winding such length of paper off one roller and on to another, substantially in the manner and for the purposes set forth.

3,572. "Improvements in printing telegraph receiving instruments." J. E. Wright. (Under International Convention.) Dated November 16th, 1892. Consists of a new column or page printing telegraphic instrument, in the construction and design of which the main object has been to provide a compact, simple and effective instrument, more especially adapted for private lines, or smaller systems, where the amount of work demanded of the instruments is comparatively light, or exceptional speed is not required. 9 claims.